Abstract

Enterprise Asset Management world is growing due to companies are changing their mindset; from corrective maintenance measures to predictive ones. It is sought then a tool able to make habitual follow-up of the state of assets that customers own.

The main focus of the present project is to develop a paperless technology able to make inspections to check these industrial assets status. And as a second goal, to allow companies to measure the performance of their field workers throughout the inspection processes.

Regarding project's scope, it presents a double solution: a cellphone app to acquire asset data and an enterprise website to store, administrate and analyze collected information.

Furthermore, the project content includes the product description to create and it's planning for development. Solution's main features are stated in order to outsource its posterior production to a 3rd party company.

To sum it up, this venture will provide a useful tool for companies with large amount of valuable assets they want to monitor.

Summary

ETSEIB

1. Glossary

Name	Description
API	An Application Programming Interface (API) is a set of routines, protocols, and tools for building software applications.
Asset	Anything tangible or intangible that is capable of being owned or controlled to produce or have positive value
CAGR	Compound annual growth rate (CAGR) is a business and investing specific term for the geometric progression ratio that provides a constant rate of return over the time period.
CAPEX	Capital expenditures (CAPEX or capex) are those altering the future of the business. A capital expenditure is incurred when a business spends money either to buy fixed assets or to add to the value of an existing fixed asset with a useful life extending beyond the taxable year.
Cloud	Cloud computing allows application software to be operated using internet-enabled devices.
CMMS	A Computerized maintenance management system (CMMS) software package keeps a computer database of information about an organization's maintenance operations.
CRM	Customer Relationship Management (CRM) is a system for managing a company's interactions with current and future customers. It often involves using technology to organize, automate, and synchronize sales, marketing, customer service, and technical support.
CSV	A comma-separated values (CSV) file stores tabular data (numbers and text) in plain text. Plain text means that the file is interpreted a sequence of characters, so that it is human-readable with a standard text editor.
Dispatching	Dispatching is the procedure for assigning jobs to employees. In this specific case, managers dispatch work orders to inspectors.
EAM	Enterprise asset management (EAM) is the optimal lifecycle management of the physical assets of an organization. It covers subjects including the design, construction, commissioning, operations, maintenance and decommissioning/replacement of plant, equipment and facilities.
ERP	Enterprise Resource Planning (ERP) is business management software that a company can use to collect, store, manage and interpret data from many business activities
FAQ	Term to refer to frequently asked questions made by customers.

Name	Description
Form	Document with spaces (also named fields or placeholders) in which to write or select, for a series of documents with similar contents. Forms are filled by inspectors.
Front End	Software engineering term referring the presentation layer. A rule of thumb is that the front (or "client") side is any component manipulated by the user.
FSM	Field service management (FSM) refers to a hosted or cloud-based system that combines with hardware and internet service to support companies in locating vehicles, managing worker activity, schedule and dispatch work, ensure driver safety, and ideally integrate with inventory, billing, accounting and other back-office systems
GIS	A geographic information system (GIS) is a system designed to capture, store, manipulate, analyze, manage, and present all types of spatial or geographical data.
Inspector	The person who fills forms describing the status of assets. Inspectors are the target to use the mobile app described in the project.
IRR	Internal Rate of Return (IRR) on an investment or project is the "annualized effective compounded return rate" or rate of return that makes the net present value (NPV as NET*1/(1+IRR)^year) of all cash flows (both positive and negative) from a particular investment equal to zero..
Manager	The person who receives forms, gather its information and extracts outputs from them. They also monitor inspectors. Managers are the target to use the website described in the project.
NPV	Net Present Value (NPV) is defined as the sum of the present values of incoming and outgoing cash flows over a period of time. NPV is determined by calculating the costs (negative cash flows) and benefits (positive cash flows) for each period of an investment.
OPEX	An operating expense or OPEX is an ongoing cost for running a product, business, or system. For large systems like businesses, OPEX may also include the cost of workers and facility expenses such as rent and utilities.
PDA	A personal digital assistant (PDA), also known as a handheld PC, or personal data assistant, is a mobile device that functions as a personal information manager.
Site	Term to identify a point or an area on the Earth's surface or elsewhere. In this case, the site is the place that contains an asset or a group of assets to monitor.

2. Preface

The object of study of the project is the Enterprise Asset Management. This term refers to the monitoring of the physical assets of an organization. To gather the necessary information to make decisions regarding its maintenance, several approaches can be used.

Since we live in the era of smartphones, the project takes advantage of this historical circumstance and the change in people's lifestyle, trying to integrate the use of phones during worktime.

The reasons stated above will be split in several categories. To make it specific, this section will include the original idea, the motivation to transform the idea into a real solution, and some requirements to be taken into account to understand the project's approach.

2.1. Project origin

The idea behind this project comes from direct feedback given by a client of the company where this project was developed in.

The aforementioned customer wanted a solution to monitor the assets they possess. In addition to this, they also wanted to have information of the workers monitoring those assets.

Nevertheless, since the company already had an expensive solution to handle this job, the focus of the project was a mid-quality technology to make it cheaper.

Lastly, the goal of the developing company was to create one more service in order to cover as many sectors in the market as possible, which, in turn, would generate more revenue.

2.2. Motivation

The motivation of this project is taking a step forward in the usefulness of mobile phone in our daily lives. For hundreds of years, people wanted to keep track of all goods possessed. The approach for keeping information was by writing forms and storing them for further reviewing.

But nowadays, the inclusion of internet in our lives and intensive mobile phone usage gives a new insight to the industry. It is possible to gather information about our pertinences quicker, and later storing them in computers. Computers make possible the interaction with the information, it's sharing with other people, and visual representation of the forms data.

The chain of value has changed, being now possible to change deductive maintenance into predictive one.

Hence, developing a technology which changes the way to monitor owned assets might give people the tools for a great boost in productivity.

2.3. Previous requirements

To understand part of the decisions taken in the development of the project, two ideas must be taken into account.

The first one is that the project is developed in a company. Some features to be included in the document are influenced by the company's management point of view. Although the author of this project wanted to separate the personal optimal solution from the company's solution, the coherence of the project as a whole led to include part of the latter.

Moreover, the influence of the customer and the market can also be noticed. Client needs must be taken into account, for they are those purchasing the product. Finally, competitors who offer similar solutions may influence whether decisions are taken or not.

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3. Introduction

All companies must check the status of their assets. An asset can be understood as a good, such as a fire extinguisher. An asset can also represent a person, such as the staff of a security company. Or it can be a building, such as the ones created by construction firms. Even groups of people who may not be a company might want to keep track of their belongings. Nature of assets can be very different, but the action of monitoring them is a common practice.

The management of assets covers subjects including their design, construction, commissioning, operations, maintenance and decommissioning or replacement. Asset management uses the approach of monitoring the current status each good has at each moment.

Normally, the amount of status to take into account when checking those assets can be really different, depending on the company's segment. Many aspects of an object can be studied: its lifecycle, its depreciation costs, or even the amount of time where it's been placed.

Asset Management solutions let companies finally have an inductive type of analysis, through real-time observation and measurement.

Workers given the duty to monitor assets are known as inspectors. The inspectors' job is to keep track of the state of each asset their company owns, and to fill a pre-defined form with a list of parameters to check and their current state.

Later on, the information filled through forms must be gathered, analyzed and synthesized in order to make the necessary decisions considering its status. This mission is assigned to managers, employees normally working in the same company as inspectors, but with a higher level of responsibility.

Hence, the relationship between inspectors and managers must be taken into account. A proper communication between both bodies ensure the quality of data acquisition and management. This is the company's main interest when investing in this type of solutions.

3.1. Project goals

The main goal of the project is to develop a service giving the necessary tools to both inspectors and managers to do their job.

To fulfill the first part of the goal, a form-filling smartphone app for inspectors will be described. The second part involves the description of a website for managers to handle data coming from inspectors.

The aforementioned solution pursues to accomplish a series of actions:

- To be able to submit forms in a fraction of time
- To provide visibility & control measures over assets
- To keep track of inspectors' performance monitoring assets
- To manage incoming data and providing outcomes from the inspection process

3.2. Project scope

Since the project is in its first stages of development inside a company, the scope of the document is to provide the required information to ensure the product's sustainability. On one hand, part of the project will cover data to satisfy the company's management to invest on its development in a short term basis. On the other hand, the file should state the necessary steps for the engineering department to actually develop both the app and the website.

Overall, the sum of all stakeholders' needs will translate into the following points to be included:

- Documentation regarding precedents of this technology
- Studying the actual state of the Enterprise Asset Management market
- Description of the technical product features for its posterior implementation
- Planning of costs to develop the product
- Creation of a business plan to commercialize the service

4. Market analysis

4.1. Overview on the market structure

To develop a service useful for the market's needs, it is necessary to study those need trends first. The following figure (Figure 4.1.1) is a representation of the several modules in which the EAM world can be divided:

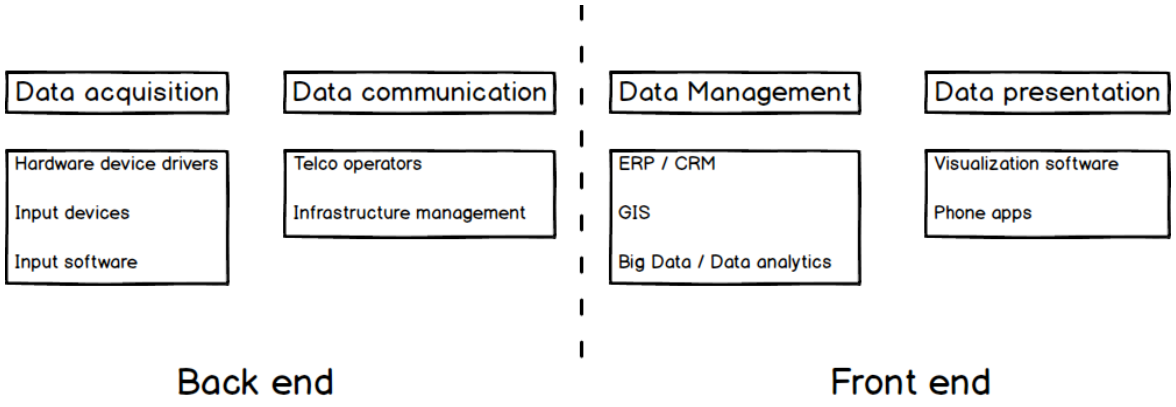

Figure 4.1.1 Graphical division of EAM market by modules

The previous figure is split this way due to this being the chronological path of data, from its source to the customer. Data is collected from the asset we want to monitor, then sent to a storage system. Once all data is gathered, the next step is its analysis and integration with other company tools, such as the Customer Relationship Management and Enterprise Resource Planning systems. Once analyzed, information conclusions are presented to customers so they can make the necessary decisions. This process can be simplified in 2 blocks:

- Back end, which includes all tools related to accessing data
- Front end consists on the usage of data

Depending on the resources of the company, more or less modules can be added to the project's solution. A higher budget to spend in product development, as well as more human resources that may work in each phase of the project, ensure a solution offering a wider range of services to be provided.

The main stakeholder affecting our decision is the customer. If customers are using a feature including other companies' services, that feature will be taken into account for this project.

4.2. Customer needs

A survey was done by IBM [1] to a total of 1000 companies regarding EAM practices and investments. Some companies were using EAM solutions and some were not. Over 20 sectors in more than 15 different countries were included in the survey. Company size ranged from less than 100 employees to more than 100000. Hence, the results of the survey can be considered valid to have a general idea of the market's customers' needs.

4.2.1. Features to include

In the following graph (Figure 4.2.1) a first aspect to consider is represented: companies' goals of which modules of EAM were going to be used in short-term and mid-term:

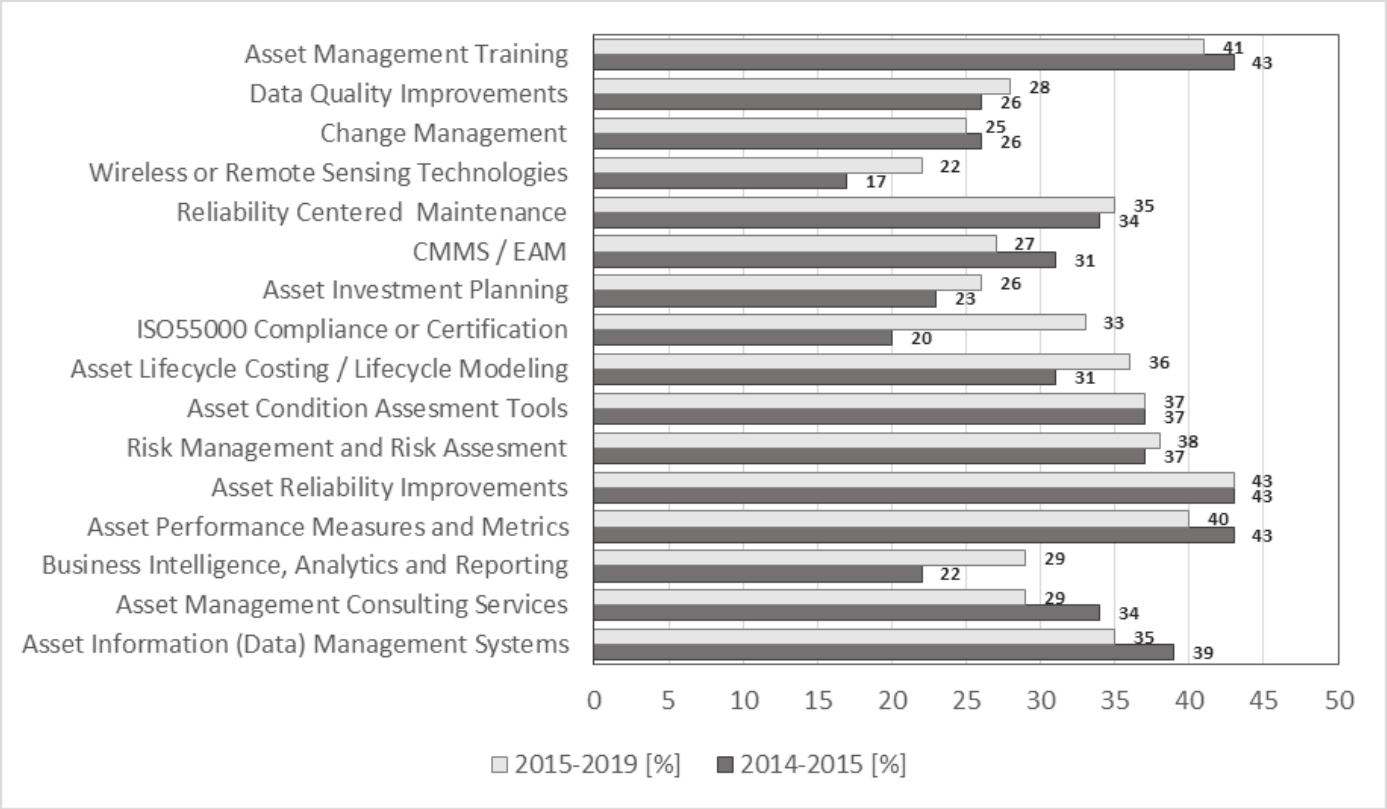

Figure 4.2.1 Mid-term vs Short-term goals in EAM solutions

The first output is the improvement of asset reliability in both short and long term (43%). This aspect can be covered through checking the outputs from measuring the asset performance through metrics, which is the tied most voted option (43% in short-term). The management of the measured data is the obvious step to get useful information out of its acquisition (39% short term).

Lastly, a top voted option is that customers consider a key point to provide training to their employees regarding EAM software (43% short-term). Goals remain stable regardless of whether it is short or mid-term. This is a good point for EAM solution developers, for their products will have the expected value for a longer time in the market.

All top-voted concepts have quite a clear explanation of the services they may include, except for the Asset Information Management System. The range of features to enhance this aspect is wide. Another question was done to customers regarding their top 3 features in this segment (Figure 4.2.2).

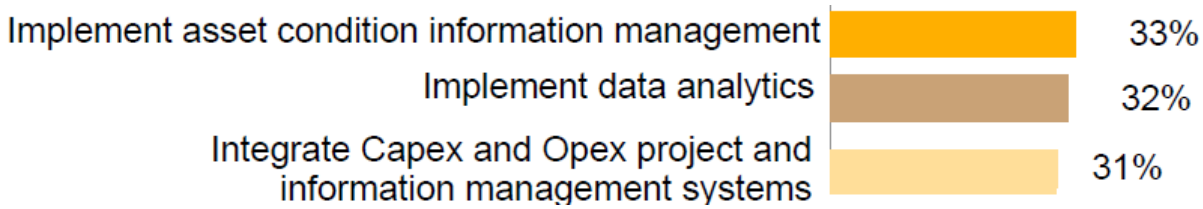

Figure 4.2.2 Top three plans to improve Asset Information Management

The top voted aspect to strenghten is the management of assets' condition. The value chain of the service goes up when the data from the previous point is analyzed. Last, keeping track of the company Capital and Operational Expenditures is a nice add for the customer.

4.2.2. Study conclusions

The previous study is a good reference in order to consider the higher valued features of and EAM solution. From here, it is a goal of the project to combine the tools to supply customer needs and the capacity to provide the service.

In Figure 4.1.1 data was structured following its path in the business. It is sensible to try not to skip adjacent modules of the data flow. To sum up, the project's solution will try to include the top voted options in its service (the module they belong to is specified between brackets):

- Asset Performance Measurement (Data Acquisition, Communication & Management)
- Asset Information Management (Data Management)
- Asset Management Training (Data Management & Presentation)

As it can be seen, providing the best service to clients means adding solutions regarding all modules of the Asset Management structure.

Improving better asset reliability is considered more of a consequence than a tool to achieve customer satisfaction.

4.3. EAM market by numbers

4.3.1. Market size & growth

Size estimations are done in 5-year periods. The amount of free data regarding the topic is limited, so the approach to have a clear evolution of the market is by merging minor studies. Figure 4.3.1 is the union of several different analysis of the market [2] [3] [4]. It is stated the period of time, its revenue and it's Compound Annual Growth Rate (CAGR).

Period of time (Years)	2008 - 2013	2009 - 2014	2011 - 2015	2012 - 2017	2013 - 2019
Revenue increase ($ million)	1856 - 2178	1760 - 2300	2200 - 3000	2700 - 3800	2490 - 4230
CAGR (percentage)	3.2%	5.6%	6.7%	7.2%	9.6%

Figure 4.3.1 Enterprise Asset Management market evolution, 2008-2019

The visual representation of the previous data can be observed in a plot (Figure 4.3.2). It must be stated that there is a mix of real numbers with estimations. For example, the year 2013 appears as an estimation in the study 2008-2013, but the real data is inside the 2013-2019 study. Latter data has been used instead of former one.

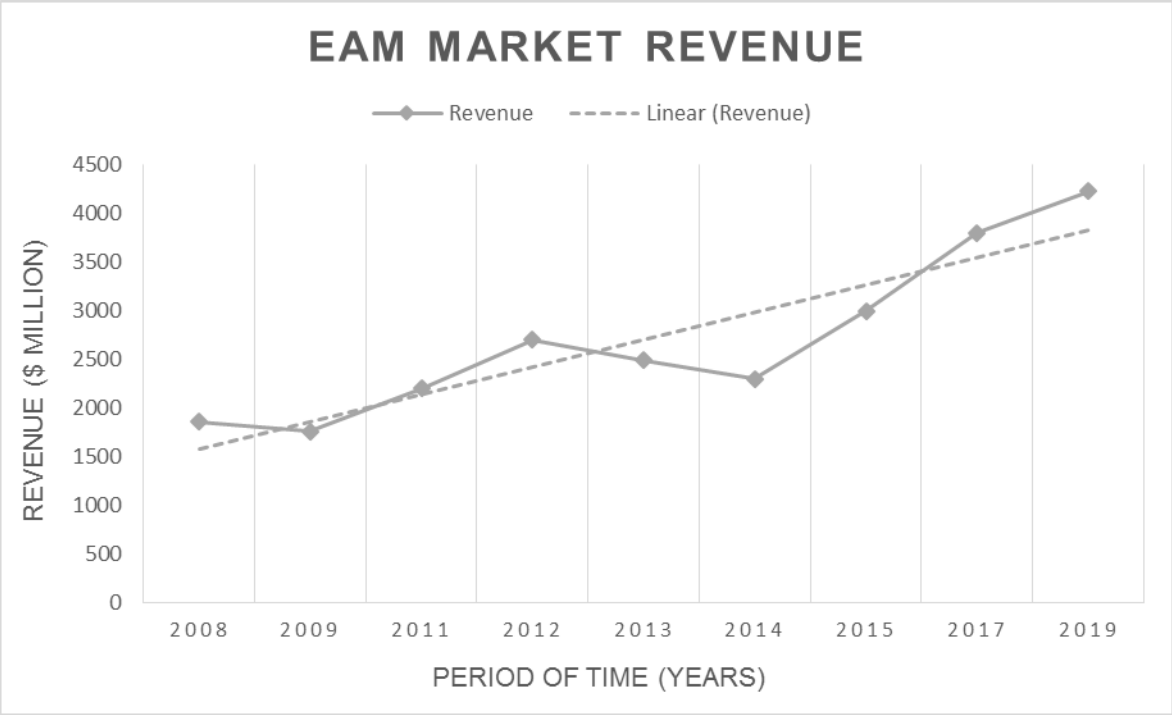

Figure 4.3.2 EAM Market revenue tendency, 2008-2019

The main outcome is the tendency of the market to increase its revenue steadily. There are some downs that can be explained with 2 facts:

- The year 2009 was the start for industrial companies to suffer the financial crisis from 2008.

- The downward tendency between 2012 and 2014 is an error caused by the followed approach. Estimations are always done in an optimistic mindset. Since the data used for the year 2013 is the real revenue (lower than the estimation one), its value is lower than the ones estimated, but it is real.

As stated before, estimations are quite optimistic, and that has a direct impact on the CAGR. Its significant increase period by period is a mixture of a real up-trend plus the impact that reasearchers of the study have. The previous numbers about the market are presented by big players of the field; it is of their interest to show that their market is growing.

4.4. Market trends

Incorporating all new market additions is an impossible mission, since in the period of time this project is being developed new functionalities will appear.

Nevertheless, a study to EAM software vendors has been done to have a market overview (Figure 4.4.1). This study is a collection of the main challenges facing the EAM market and the approach used by vendors to face them.

General impressions from the study are that the current industry is addressing a much more complex world. As a general guide, the volume of business data worldwide, across all companies, is doubled every 1.2 years.

In this breakneck increase of information, solutions related to its management are a must for companies who want to be up to date.

Trends facing EAM solution vendors	EAM solution vendors' response
Smarter, more complex, and more costly assets	Solution specialization in a module vs Integral solutions
Greater focus on risk due to the previous point	Focusing in a size of customer
Digitize knowledge from aging workforce	Area specialization (health, manufacturing, oil & gas, etc.)
Global reach such as handling multiple languages and currencies, as well as multiple companies, sites, and warehouses	Features applicable to a wide variety of industries
Blurring the separation between operations and maintenance	Industry-specific features
Potential focusing on sustainability	One or a few industries to target
Defining “asset ownership”	Core framework software and a flexible configuration tool that can be used to tailor solutions
Great increase in data	Technology platform (private or public cloud, web-based or client/server architecture, etc.)
Context sensitive to the use of mobile phones everywhere	Functionality of the solution; features included
	Pricing

Figure 4.4.1 Trends facing solution EAM vendors and their response, 2013

5. Prior art

Once defined the goals of the project, it is a must to study the different possibilities to solve the given situation. In the professional world there is a fact that keeps true in most fields: if it generates some profit, somebody must have tried to benefit from it.

Hence, it is necessary to spend the initial part of the project planning to check the competence in the Enterprise Asset Management market. The following pages will be used to state and describe the current competency offering similar solutions, and the features their service provide.

5.1. Big players

Enterprise Asset Management companies classification (Figure 5.1.2) has been made to follow the EAM modules scheme used in the market analysis. This approach makes it visually easier to check which segments are leaded by each player. As a remark, although most companies are stated in one module, this is because they are specifically strong in that aspect. Most big players offer integral solutions; their solutions involve all fields of the EAM by themselves, or by incorporating specific modules developed by smaller, more specialized companies.

The evaluation criteria to determine which companies lead a segment is based on a series of different factors. (Figure 5.1.1)

General	Sales	Strategy	Marketing	Service
Overall viability	Sales execution	Geographic Strategy	Marketing Execution	Product service
Operations	Pricing	Offering (Product) Strategy	Marketing Strategy	Customer Experience
Innovation	Business Model	Vertical and Industry strategy	Market Responsiveness/Record	
	Market Understanding	Sales Strategy		

Figure 5.1.1 Criteria to define a market leader

Factors are extracted from Gartner's Magic Quadrant [5]. Gartner provides analysis of every single field of industry, and therefore creates a square table establishing the market leaders, challengers, visionaries and niche players.

Not all factors contribute in the same weight to determine which solution is more optimal. Figure 5.1.2 shows criteria used by Gartner to score all players' products:

Evaluation criteria	Weighting
Market Understanding	**High**
Marketing strategy	Medium
Sales strategy	Medium
Offering product strategy	**High**
Business Model	Medium
Vertical/Industry strategy	Medium
Innovation	**High**
Geographic strategy	Medium

Figure 5.1.2 Evaluation criteria of big players' solutions

The most important features are highlighted to have a clear view and what's more important when developing an EAM solution. Moreover, it is at the same time the most useful aid to create our product given the scope of the project.

Out of all companies stated in the comparison, the one that will be used to follow especially in the front-end division is IBM. They are the favorite company of customers, and the one publishing more free documentation for research purposes.

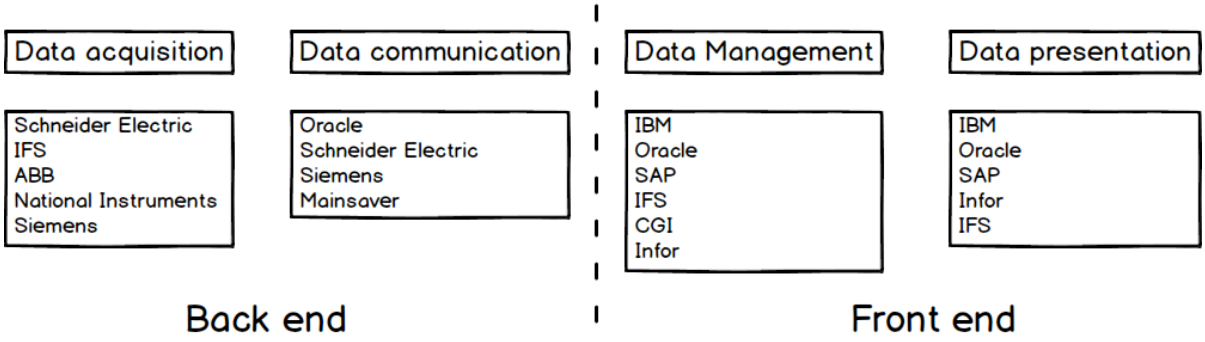

Figure 5.1.3 Market leaders, divided by module

Using the criteria stated in Figure 5.1.1, each leader is evaluated from one to five stars in each field. Figure 5.1.4 is the table showing the results:

Company	General	Sales	Strategy	Marketing	Service	Total score [out of 25]
IBM	****	*****	*****	*****	***	22
SAP	****	****	***	***	****	18
IFS	***	**	***	***	****	15
Oracle	****	****	****	*****	**	19
Infor	***	***	***	****	*****	18

Figure 5.1.4 Market leaders evaluation

IBM solution, IBM Maximo, will be the model to imitate regarding our front end solution, the website. Their solution is really good in most of aspects, though the project solution will try to improve some of their week aspects:

- Customers state significant hardware requirements to run applications
- References, customers and prospects report that costs to maintain are very high
- Industry add-ons come for an extra cost
- Mobile strategy offering is unproven in production

5.1.1. Back end alternatives

Information provided by big players about their data acquisition and communication is null. For this reason, back-end competence had to be separated from the overview. Figure 5.1.2 is a table showing those specialized companies in the first 2 modules of the market.

From these companies we can extract inputs in order to develop the cellphone app solution. It is useful to remind that the mobile app is the data acquisition and communication tool, and the website takes care of data management and presentation.

Company	Modules	Common pricing (per user)
GoCanvas	Back end + Data management	$31/month
Prontoforms	Back end + Front end	$25/month*
DataField	Back end + Front end	$99/month
Snappii	Back end	**
Formstack	Back end	$249/month (20 users)
Wuffoo	Back end	$29/month (5 users)
Zenput	Back end + Front end	**

Figure 5.1.4 Data acquisition and communication competitors

*Prontoforms pricing strategy will be extensively discussed

** Meaning is “request a demo”

For the app developers, another table has been made to evaluate several fields from one to five stars. Figure 5.1.5 is a recompilation of the previous companies stated.

Company	General	Pricing	Strategy	Marketing	Service	Total score [out of 25]
GoCanvas	***	****	*****	****	***	19
Prontoforms	*****	****	*****	****	*****	23
DataField	****	***	***	**	****	16
Snappii*	**	-	****	***	***	12
Formstack	***	*****	****	****	*****	21
Wuffoo	**	*****	***	***	***	16
Zenput*	****	-	****	****	***	15

Figure 5.1.5 Back-end leaders evaluation

* Snappii and Zenput can only be evaluated out of 20 points

5.1.2. Sum-up & decision making

In comparison to the big players, these app-developing companies have a significant smaller size. Their service has been specialized to back end most of the times, allowing them to enter the market with economical solutions.

To pick a company as a reference, Prontoforms is a success case regarding this field. Even though they are famous for their back-end formula, they also provide good quality data management and presentation, for an extra charge.

This is the invoicing approach that will be used for this project. Their formula will be studied later on in the pricing chapter.

5.2. Standard features

The following chapters allows to see why the two companies were taken as an example for their modules. In the figures 5.2.1 and 5.2.2 the main features of each service will be stated. In the case of IBM and their product, IBM Maximo [6] [7] [8] [9], only the front end specifications are listed.

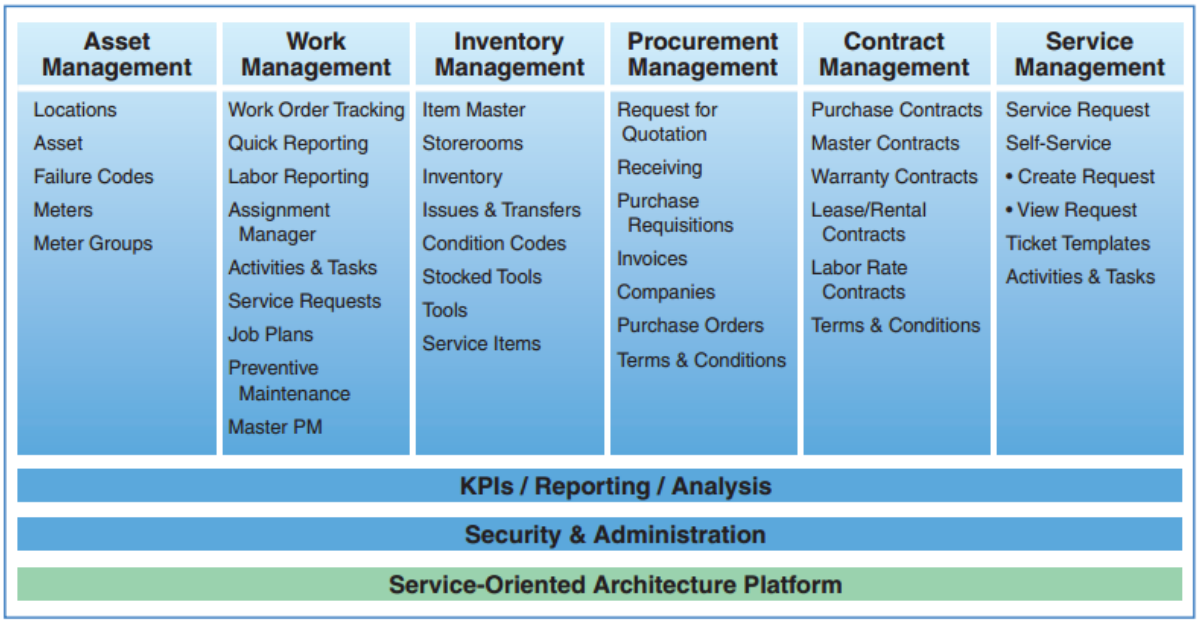

Figure 5.2.1 IBM Maximo Asset Management Essential applications

Though one of the six divisions is called “Asset Management”, the whole service is the one analyzed. As it is listed, when monitoring an asset and their users (the main goals of this project), many different aspects pop-up that are needed to offer a solution.

Figure 5.2.1 is called applications because they do not represent specific features. The complete list of features is variable, since acquiring an IBM Maximo license allows customers to have a tailored solution by IBM.

Nonetheless, the previous picture is a good starting point to discuss the specific features that the project will include. The complete list of features will be stated in the product development chapter of the project.

In the case of Prontoforms [10], their features sum-up is way more specific. The following Figure includes 2 of the 4 modules of the EAM value chain:

Data acquisition	**Data management**
Mobile app	**Online website**
Dispatching of forms	Creation of unlimited custom mobile forms
Signature, picture & barcode capture	Dispatching of work orders - Improve speed and data accuracy
Sketch Pad	Generating Custom branded PDFs
Offline form functionality	Big Data Intelligence with Prontoforms Analytics
Credit card processing	Setting up of data connections
Fully compatible on all mobile devices	Managing users and groups
GPS and time stamps	Proof of Location and Time
Embed external data sources to app	
Calculations	
Advanced input controls & Skip Logic	
Calendar integration	
Voice-to-text	

Figure 5.2.2 Prontoforms solution features

Information stated by Prontoforms is more precise. One explanation can be that their solution is rigid, so they can promise to all customers the same features when purchasing a license.

5.2.1. Conclusions of the study

In a similar way as IBM, Prontoforms' features will be taken into account for the development of both the app and website services.

Neither features regarding Data Communication nor Data Presentation ones are explained. The reason of the first point is the lack of available information. Only by trying the service provided by Prontoforms, knowledge can be acquired. Data Presentation of Prontoforms is very simple, implementing a tool to visualize graphs created through analytics. [11]

Furthermore, the solution of Prontoforms was tested for 3 weeks, in order to discover all strengths and weaknesses of their service. The general impression was very good, and the project goal is to improve the areas that customers motivating the project creation wanted to strengthen.

With both IBM and Prontoforms solutions serving as references, the following chapter will introduce us to the development of our own solution, consisting on the phone app and the website.

6. Product development

6.1. Introduction

During the project goal setting, it was stated as the main aim to provide a mobile solution to professionals related to the inspection of industrial assets. Moreover, the second part of the goal was to create another tool for the staff in charge to manage smoothly data coming from inspectors.

Therefore, the structure that this block covers is directly represented as the process of making an inspection. Figure 6.1.1 is a graphic explanation of what will be described with words in this chapter:

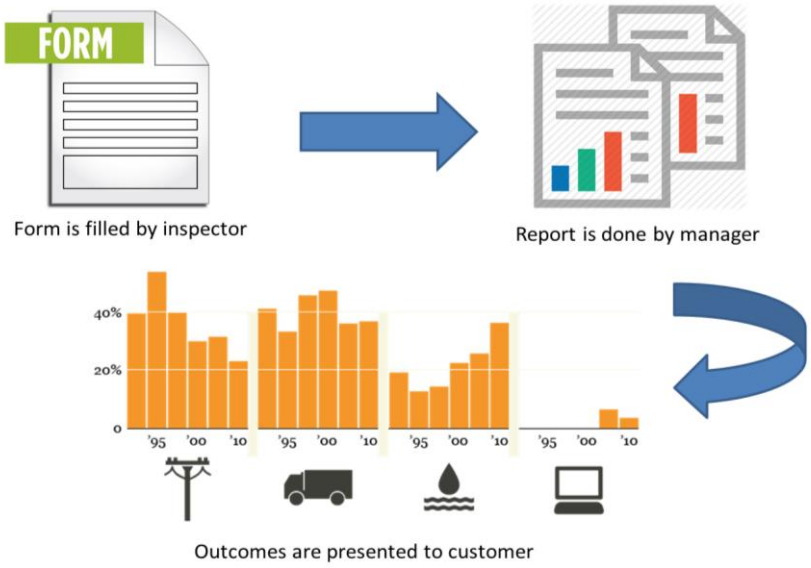

Figure 6.1.1 Process of main stakeholders involved in the solution

1. First part will involve data acquisition by inspectors. Afterwards, an in-the-middle process between inspectors and managers happen; communication and storage of collected data.

2. Once information is in the hands of managers, all related features to enable desired data management will be explained.

3. Last but not least, conclusions from the analysis of data are presented to the interested customer, in order to take the necessary decisions. This aspect will also be covered.

6.2. Data acquisition

6.2.1. Description of the inspection process

When an asset needs to be checked, an inspector is dispatched to monitor its status. To be aware of the asset to inspect, its location and time of the inspection, a notification system of inspections is sought. A simple system to empower communication between inspectors and managers is via mailing. Hence, when an inspector starts his laboring day, the app's inbox is checked (Figure 6.2.1.1). In order to see the when and where of the inspection, mobile forms to be used to monitor the status of assets is attached.

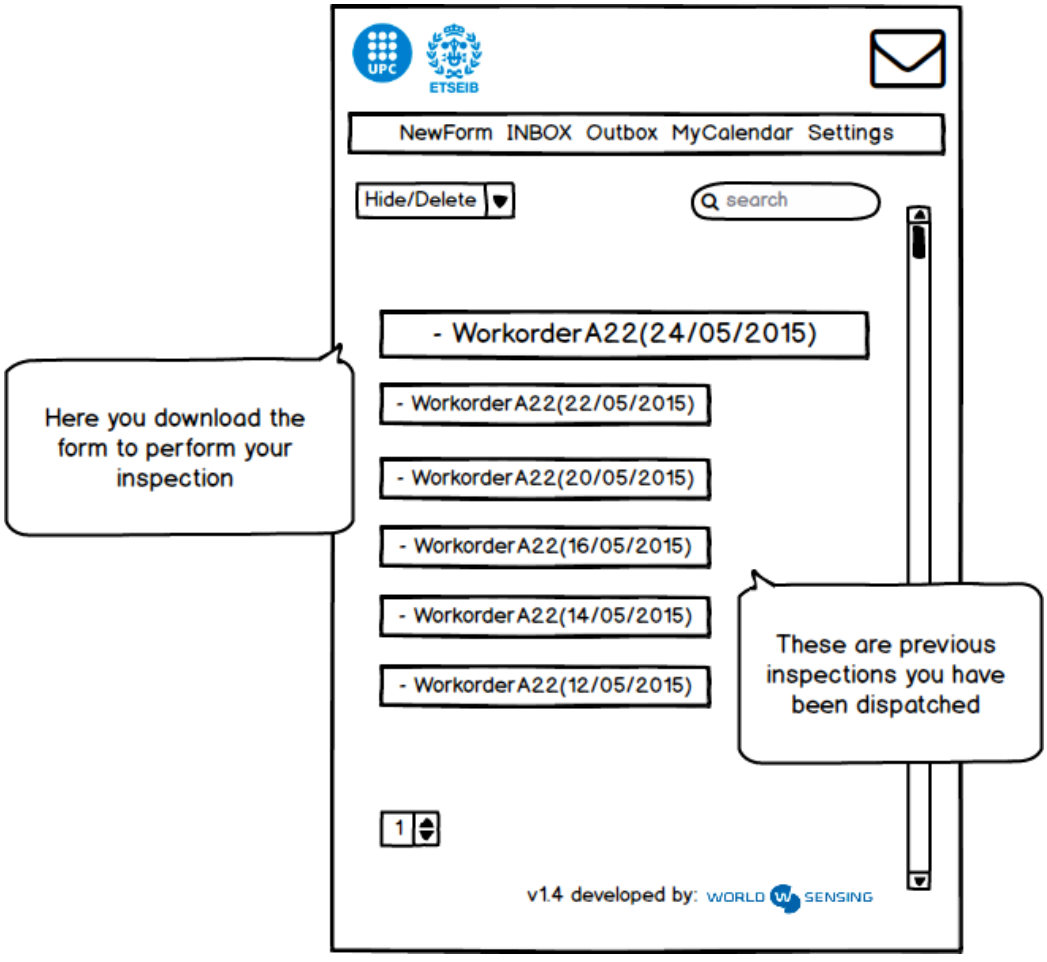

Figure 6.2.1.1 Inspectors' app inbox design

The inspector then proceeds to fill the fields that managers included in the form layout. For example, a list of common spaces to be filled would be the following (Figure 6.2.1.2):

- Basic information
  - Regarding the asset
    - Name of the asset → "fire extinguisher"
    - Type of the asset → "Model XJP-CO2"
    - Serial number → "22561" (written number / barcode)
    - Asset location → *GPS tracked**
    - Site location → "Building C5 in street Gamma, number 12"
    - Owner → "Construction company Beta"
  - Regarding the inspector
    - Name of the inspector → John Doe
    - Date & hour of inspection start → *Cellphone tracked**
    - Notes about previous inspections → "Replaced 2 weeks ago"
    - Calendar of future inspections → *App tracked**
- Asset status
    - General aspect → Good / To be repaired / To be replaced
    - Description of visual observations → "Asset ID tag is blurry"
    - Additional support → *Picture*
    - Stamping of inspector signature → *Manual signature*
    - Date & hour of inspection end → *Cellphone tracked**
- Form destination
    - Send form to → *Mail direction / Cloud account*

Figure 6.2.1.2 Example list of form status

* To be explained further

Further to the information of the asset to monitor, extra fields are added in relation to the person responsible for the inspection. This addition enables customers to gather data about staff. Its posterior analysis enables tracking their working performance.

A point to state is that managers have the chance to add the fields they desire to the form. This system makes the app more flexible and adaptable to the customer's needs. However, this becomes a challenge for the development of the website. Data is unstructured, for the number of fields and their type (alphanumeric input, multiple choice answer, graphic support…). The way to handle these variable data sources is taken into account in the website description (Chapter 6.4: Data Management)

6.2.2. App features

The previous example is a good way to understand the form-filling process. The next step is to describe all features related to the app. Annex B: App List of features is a tree stating all necessary fields that the data acquisition module will include, at a high level.

Since the complete list is quite exhaustive, a sum-up of the main focus areas of the app are described in Figure 6.2.2.1. The table is structured in a practical way, since features are separated in the several menus of the app dock.

Moreover, Annex C: App mock-ups lets us have a visual representation of the mobile app. Both these annexes are key documents to handle to the team of programmers involved Wireframing and interface coding.

NewForm	Inbox	Outbox	MyCalendar	Settings	Inspector performance	Other features
Create form	Import of files	Submission of forms	Import of files	Choose language	Amount of forms filled	App download
Select form	Edition of forms	Edition of forms	Visualization of files	Account details	Status of inspector	Performance
File import	Form search	Form search	Form search	Contact	Comparison of performance	App version
Fields filling	Order of forms	Order of forms	Order of forms	Graphic quality	Presentation of performance	Branding
Non-editable		Storage of forms		Help		Security
Submission				Feedback & suggestions		
Auxiliary						

Figure 6.2.2.1 High level list of app features

The app dock of the app is the place to access each menu. Figure 6.2.2.2 is a mock-up to provide us with an idea of how this tool will look like in the presented version:

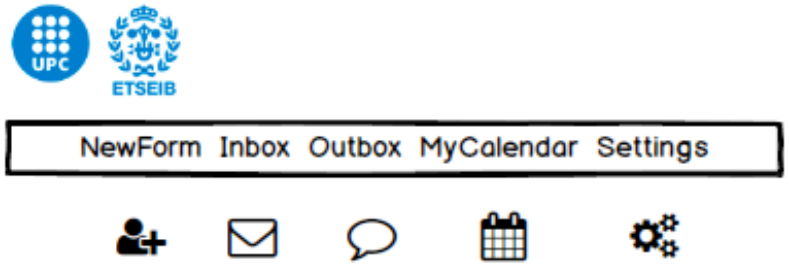

Figure 6.2.2.2 App dock representation

The complete list of features is embodied at a high level, due to the focus of the project being to develop a two tools solution. Technical specification of features will be written by the product developers. Useful information is added in the annexes.

Even so, some features might seem unclear for their name. Hence the explanation of each one. The list of features will be explained in a basic approach in the following tables (Figure 6.2.2.3 to Figure 6.2.2.9):

NewForm	Create/ Select	When it's time to make a new form, inspectors will have 2 options: to take the form dispatched in the inbox or using template provided by the company.
	Input system	Answering a question or filling a field may be done through a text box or by choosing from several options
	Support	To enrich the content of inspections, the ability to take pictures, record audio or video recording is provided. Also, asset ID can be read if it comes in a printed barcode or QR code
		Obligation of online signing per form allows authentication of the inspection made.
	Performance	To determine that the job is done right, the location is recorded by GPS coordinates. This way managers can check whether the asset is located in its site
		Inspectors are asked to mark the time of start and end of inspection to analyze the time spent in each inspection
	Submission format	The most common format will be HTML, to allow analysis on the website. Even so, a non-editable version of the form can be send in PDF or Word format

Figure 6.2.2.3 NewForm description

Inbox	Import of files	Form will be imported in HTML format to be able to fill them. Additional information can be downloaded in a PDF or CSV format
	Edition of forms	Inspectors can download dispatched forms, hide them if not needed or event delete them
	Form search	If looking for a specific form, a bar with a semantic engine allows to search by writing the ID/name of the form
	Order of forms	Newest forms appear by default, though order can be changed. Number of forms per each page will be limited to allow clear vision

Figure 6.2.2.4 App Inbox features description

Outbox	Submission	Sending forms by default is automatic when access to internet is possible. The option can be changed to send them when desired
	Storage	Forms sent will be stored by default. The other option is to delete them once sent
	Edition of forms	Inspectors can hide forms if not needed or event delete them
	Form search	If looking for a specific form, a bar with a semantic engine allows to search by writing the ID/name of the form
	Order of forms	Newest forms appear by default, though order can be changed. Number of forms per each page will be limited to allow clear vision

Figure 6.2.2.5 App outbox features description

MyCalendar	Import of files	A calendar with the next inspections to make will be downloaded in HTML format. A non-editable version can be downloaded in PDF
	Visualization of files	Inspectors will be able to check each future inspection by watching date, location and form to use
	Form search	If looking for a specific form, a bar with a semantic engine allows to search by writing the ID/name of the form
	Order of forms	Newest forms appear by default, though order can be changed. Number of forms per each page will be limited to allow clear vision

Figure 6.2.2.6 App MyCalendar features description

Settings	Language	Current version of the app will come in Catalan, Spanish, English & French version
	Account	App owners can check their username and password to access the app
	Contact	Chance to attach phone numbers to call are possible. By default, a phone number going to technical support is available
	Graphic quality	Quality of pictures and video taken can be regulated to lower the size of files submitted
	Help	Frequently asked questions are added to provide basic support. Link to the company website with tutorials is added
	Feedback & suggestions	A text box appears to let inspectors give feedback about the app

Figure 6.2.2.7 App Settings features description

Inspector performance	Metrics	The amount of forms filled per time frame or form type is shown to encourage inspectors
	Presentation	Graphical representation of performance is shown through several charts showing evolution
	Comparison	Competitiveness of inspectors is enhanced in a positive way. It is shown when the inspector average is in relation to the customers workforce average
	Status	Gamification of the process is added by giving statuses to inspectors in relation to their performance

Figure 6.2.2.8 App performance of inspectors' features description

Other features	App download	Current version of the app will only be downloaded by having a private link.
	App version	Android version of the app will only be available at the moment
	Branding	Corporate branding of the customer is possible by adding the client company logo to the app
	Security	2048 bit SSL data encryption is used (Internet one)

Figure 6.2.2.9 App other features description

6.2.3. Data acquisition conclusions

The data acquisition process is one of the great advances that cellphone usage allows. Basic paper-filling inspections takes and average of 10-15', an amount lowered to 3-5' with this technology.

Addition of many other features such as graphic support, geo-stamping or electronic signature equals and surpasses all good points of manual inspections.

Moreover, other problems of the manual inspection process are avoided, like writing mistakes, bad calligraphy or weakness of forms, made of paper.

As a weak point, the biggest problem may be the use of the app, more complex than filling a form in paper format. For this reason, technical support is provided, so as to help inspectors at any time.

All this range of benefits for inspectors are also enhanced in the following module of EAM, data communication between inspector and manager.

6.3. Data communication

6.3.1. Transmission of forms to manager

As a continuation of the previous point, form submission is the process following its creation. One of the main intentions of the service is to be able to keep track of the work done by staff. This requirement translates into a feature: data transmission should be immediate to its capturing

Therefore, it is provided the tool to send forms to its destination via the Internet. Both 3G/4G and Wi-Fi configurations are used to send forms to the managers' website (Figure 6.3.1.1).

Though suggested, there is the possibility to store unsent forms in an offline mode so that they can be sent once there is internet connection. This situation may happen in harsh conditions, such as oil rigs or mines.

Whether this situation happens, there is no possibility to track the workers' geographical stamping, for it works having access to Internet, not to GPS.

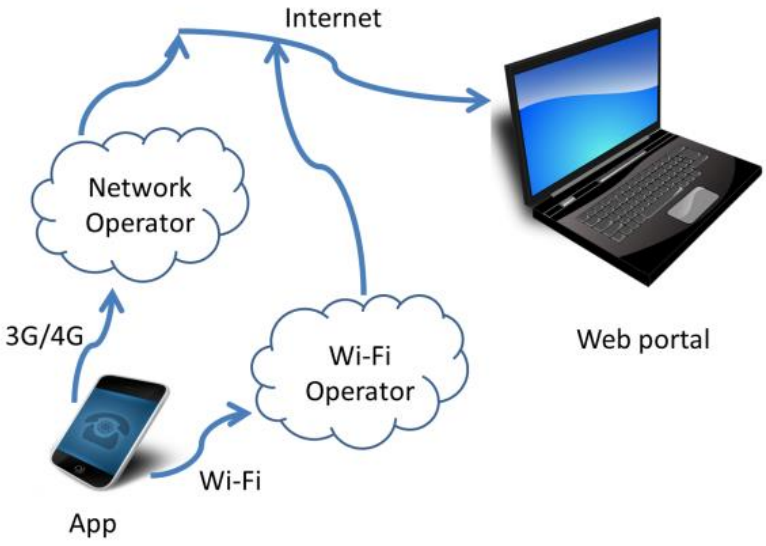

Figure 6.3.1 Communication operators between mobile app and website

Once managers have received forms, usage of collected data is of their choice. But the first step before managing data is storing it.

6.3.2. Data export: storage

In order to give total freedom to customers, information storage solution comprises 4 different approaches:

- Possibility of storing information in a 3rd party cloud storage service. Given the large amount of current services, the website should offer the possibility to be synchronized with the most popular choices (E.g. Google Drive)
- Storage of data in private hard drives. This solution is quite tedious because forms must be sent to a mail direction to download it from there, or from a 3rd Party cloud storage service.
- Finally, setting a private cloud storage system for customers. The service would be fully dedicated to the storage of data related to the EAM solution. This option requires the development of one further service, but storage is a business providing substantial benefits.
- A hybrid approach, mixing several of the aforementioned possibilities. Providing cloud storage with the possibility to download forms to the customers' hard drives is welcome as a solution

To sum up, in Figure 6.3.2 there is a compilation table of all the offered options of storage:

Data storage	Physical drive	Private	
	3rd party	Cloud Storage	Google Drive
			Dropbox
			Amazon S3
			MS OneDrive
			Sharefile
			Evernote
		Mail	Private account
	Company	Dedicated server (extra fee)	
		Dedicated mail account (free)	

Figure 6.3.2 Storage options

6.3.3. Data import: 3rd parties' connectivity

The goal of this chapter is to establish synergies between the different services of other 3rd parties that the customer may own and the service our solution provides.

The current project can become one of many services that a company uses to manage its business. This current project is focused on asset management. Assets are periodically monitored by employees. Hence, the inclusion of the main service able to monitor employees is included:

Companies often have large Enterprise Resource Planning management systems (ERP). Within this suite of different integrated applications, there is the management of human resources. The HR involved as user of the solution are the "inspectors". Customers must have the possibility to import the list of workers who will make inspections. Once the list acquired, managers of the website give inspectors their task to be done (the so-called dispatching process). This tool should enable dispatching of work orders to be automated.

The options to be considered are named in Figure 6.3.3:

Data import	ERP	Private	Salesforce
			SAP
			Oracle
		Public	Google Spreadsheet
	Format	CSV	
		XML	
		JSON	

Figure 6.3.3 Connectivity options regarding importation of files- The other option is to import .CSV files.

Private services such as SAP, Salesforce and Oracle ERP solutions are the most popular services. In addition, a free option for importing data is Google Spreadsheet. Although used less than previous solutions, providing connectivity service for free is an option for customers who do not have advanced ERP systems.

Lastly, regardless of the ERP system used, CSV, XML and JSON formats will be fully compatible with the service. The first one is especially striking, for it is used by almost all ERP systems. By having CSV format compatibility, Excel files can also be imported, though their use is not suggested for ERP labors, though vastly used. [12]

6.3.4. Dispatching of work orders

The previous compound of stated features brings us a new possibility: to dispatch massively. Before going for massive dispatching, we need to explain what a singular dispatch is.

A singular dispatch is the process of managers assigning work orders to inspectors. Each work order is mainly formed by:

The tool → the form that will be used

The target → the asset to monitor

The location → Date, time and site where the asset is placed

This process is explained in Figure 6.3.4, in the "Schedule" menu of the website. When managers access this menu, the option of dispatching appears. All previous points are included in the work order description, plus the option to add comments & explanations to facilitate the job of inspectors.

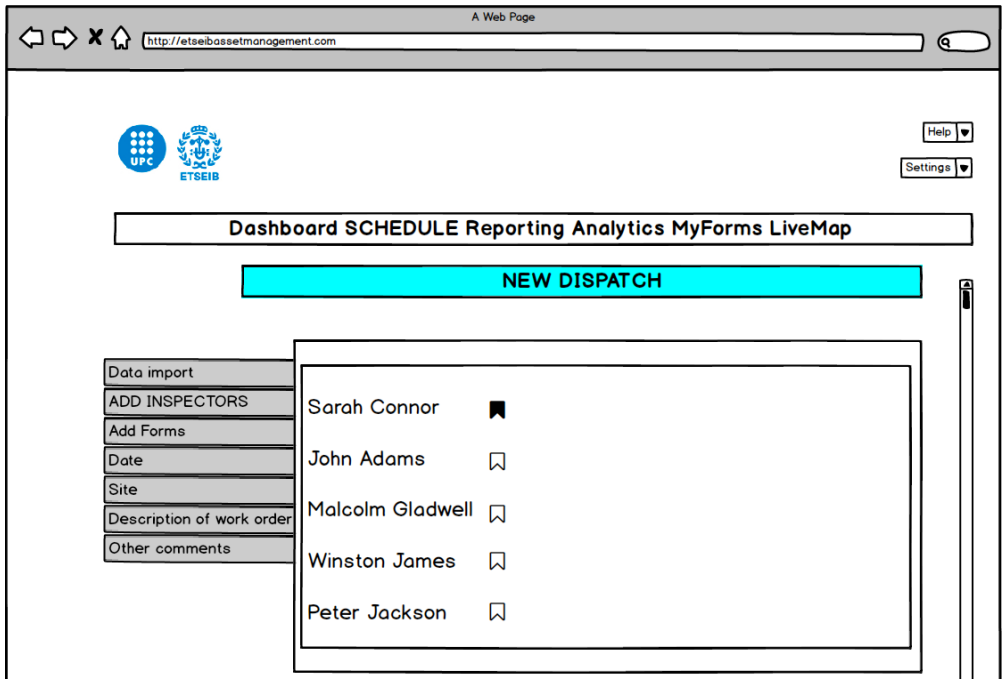

Figure 6.3.4 Single dispatching option inside the Schedule menu

Once here, massive dispatching takes advantage of data importation from the clients' ERP. With a single click, this tool allows to send multiple work orders to different inspectors for the same lapse of time. Hence, it is possible to mobilize entire teams of staff dedicated to data acquisition in a single command.

6.3.5. Data communication conclusions

Communication between inspectors and managers can range from almost none to instant feedback. The stated technology is focused to the latter state, since management of dozens of inspectors taking care of hundreds of assets turns into a complex world full of data. Figure 6.3.5 is a chart representing the interaction between the main characters of the service: inspectors, managers & forms.

Usage of mobile phone facilitates greatly the task, since the time taken to send a form via internet to managers is a matter of seconds. In comparison, sending written forms to the office would take visibly more time.

And at the same time, receiving a mail in the inbox with the work to do is far quicker than visiting the working facilities to receive the instructions to start moving.

In an era of standardized cellphone use, time spent in miscommunication is reduced in a fraction of time. And this product takes this motto to a whole new level, reducing all period of time related to exchange of information.

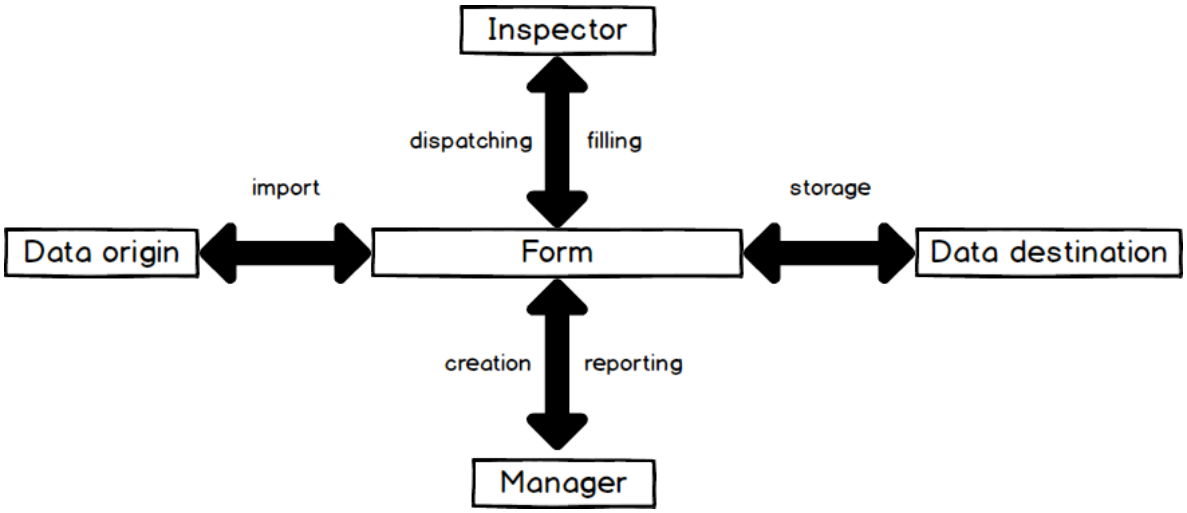

Figure 6.3.5 Relationship between the service and their users

6.4. Data management

6.4.1. Creation of forms

The app used by inspectors is strongly influenced by the manager. Managers are responsible for the creation of forms, the document containing the asset monitoring interested fields.

The form creation website offers tools to include new fields, and the questions and variables containing each field. In addition, it also allows setting default values, so that inspectors receive a suggestion by managers regarding the expected value of a variable.

MyForms is the dedicated menu to forms creation (Figure 6.4.1).

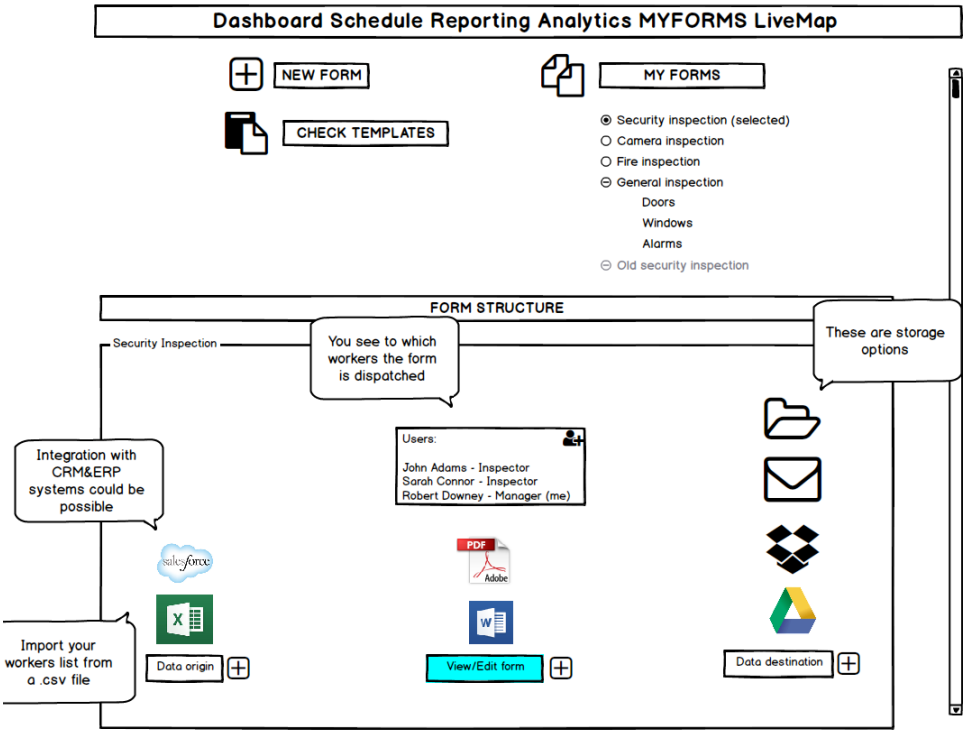

Figure 6.4.1 MyForms menu

On the other hand, MyForms is much more than a form creation tool. MyForms enables assigning inspectors with the rights to use a form, as well as other managers that can edit forms to update or delete them, for example.

Ultimately, every form contains an interface showing the relationship of the aforementioned users, plus data related tools: data import (list of inspectors, assets or sites) and destination of forms (storing or mailing).

6.4.2. Reporting

The first two EAM processes included in the project served its purpose once the manager owns the forms on the website. However, the forms are merely responded parameter files containing each field set.

The creation of a report is the extraction of conclusions of a set of forms determined by the manager. The website gives the following tools to create reports:

1. The first aspect is the selection of the specific forms used to create a report. A filtering system enables the what (asset), who (inspector), when (date and time) and where (site). Figure 6.4.2 shows the reporting interface in the website

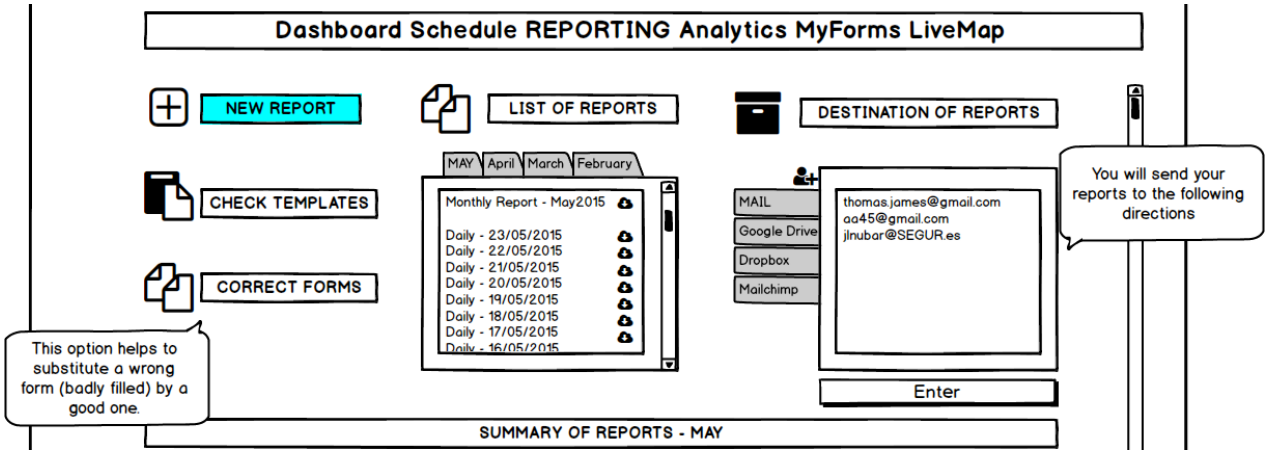

Figure 6.4.2 Website reporting menu, reports chronologically displayed

2. The second point is the work of the website's artificial intelligence. Similar to a web search (Google search), a semantic search engine identifies the relationship between variables and values. This engine enables to automatically place an order to any type of input coming from inspectors. Hence, unstructured data can be transformed to structured data. It is up to the manager to logically combine variables for his customer's interest.

3. Lastly, representation of managers' outcomes is possible thanks to the charting system, analytics.

6.4.3. Analytics

The analytics tool allows the creation of charts from reports. Each report is made of variables related to the asset inspection, plus variables related to inspectors. Hence, charts allow to assign any possible variable to each axis, so to get combinations of assets, inspectors, time and place.

Moreover, data coming from reports can be mixed with external information, via data import (in a CSV file).

It is important to clarify that analytics is a front end tool, it lets selecting multiple ways of presenting information (histograms, bar charts, pie charts, see Figure 6.4.3). Analytics does not interfere in the relationship between variable values. That part is covered in reporting.

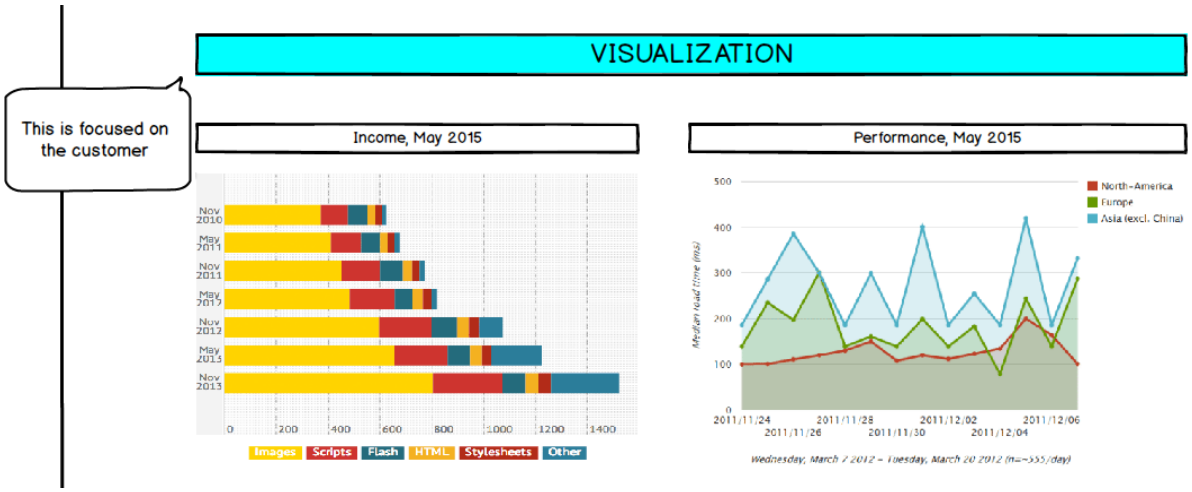

Figure 6.4.3 Example of different charts in the analytics visualization menu

In case that the manager's skills in the creation of reports/charts are not good enough, advanced analytics are provided by the project service (to see in the Business Plan chapter).

6.4.4. Website features

As written, the former two chapters take part of the second product of the project: the manager's website.

Due to the complete list of features being quite extended, each specification can be found in their location in the annexes. In this case it is Annex D: Website list of features.

In the same approach followed in the Data Acquisition module, the next figure (Figure 6.4.4) represents each header and a high level list of the website features. Features' order is the one seen in the website menu.

Schedule	Reporting	Analytics	MyForms	LiveMap	Settings
Work orders	New report	New graph	New form	Elements on map	Account details
Dispatching	Correction of forms	List of graphs	List of forms	Elements info	Language
List of inspections	List of reports	Destination of graphs		Summary of inspections	User administration
	Destination of reports	Summary of graphs			Support
	Summary of reports				Contact
	Reports search				Security
					Invoicing
					Feedback & suggestions

Figure 6.4.4 High level list of website features

To have a visual idea of the website instead of imaging it, graphical representation of each menu can be found in Annex E: Website mock-ups. Both 2 annexes state all decisions taken during the description of the project page. Moreover, the annexes are tools for the website developing team to work into programming.

Even so, some features might seem unclear if just considering their name. Hence the explanation of each one. The list of features will be explained in a basic approach in the following tables (Figure 6.4.4.1 to Figure 6.4.4.6):

Schedule	Work orders	Managers can create a calendar to state the work orders to dispatch for each period of time
	Dispatching	Assignment of work orders to inspectors in a specific day. Dispatching can be individual or massive.
	List of inspections	Sum-up of the previous inspections finished. Filtering system allows to determine the factor in which inspections appear

Figure 6.4.4.1 Website Schedule menu features description

Reporting	New report	Tool to create reports out of forms selection. Can be totally customized or using templates
	Correction of forms	Auxiliary system to substitute incorrectly filled forms for their replacement
	List of reports	Previous made reports, ordered chronologically
	Destination of reports	Mail direction or storage system to submit finished reports
	Summary of reports	Sum-up of last reports, showing several fields and their status
	Reports search	Search engine to find a specific report. Alphanumerical input searches reports by their name

Figure 6.4.4.2 Website Reporting menu features description

Analytics	New graph	Selection of report variables embodied in a chart. Graphs can be customized or using templates (income chart, lifecycle asset chart, etc.)
	List of graphs	Previous made graphs, ordered chronologically
	Destination of graphs	Mail direction or storage system to submit finished graphs
	Summary of graphs	Sum-up of last graphs, showing chart types, variables and units they represent

Figure 6.4.4.3 Website Analytics menu features description

MyForms	New form	Tool to create forms that will be dispatched to inspectors in their app service
	List of forms	Previous made forms, showing their interface. Interface includes users related, format, data origin and destination.

Figure 6.4.4.4 Website MyForms menu features description

LiveMap	Elements on map	Real-time map showing location of assets and inspectors
	Elements info	Interactive tool showing information related to each element such as status of assets, last inspection done or owner of the site
	Summary of inspections	Sum-up of last inspections done, attaching date, inspector and link to download them

Figure 6.4.4.5 Website LiveMap menu features description

Settings	Account details	Managers' username and password to access the website
	Language	Website to be translated to Catalan, Spanish, English & French
	User administration	Menu to give rights to each user, making them inspector or manager. Also, management of their accounts, passwords and general performance included
	Support	Link to the project company website, to show tutorials and frequently asked questions (FAQ) regarding the usage of both app and website
	Contact	List of several contacts, including technical support and project company consultants to hire their services of reporting and analysis
	Security	Management of data encryption and users' credentials authentication
	Invoicing	List of paying options of the service, to automatically invoice each month. Debit and credit cards are considered, as well as PayPal payment
	Feedback & suggestions	Space to let customers write their suggestions regarding how the product can be improved

Figure 6.4.4.6 Website Settings menu features description

6.4.5. Data Management conclusions

Management of data is the business in which EAM companies spend most of their resources. It is the module transforming piles of variables and values into practical knowledge for the customer to determine the value of the owned assets.

The module of Data Management in the project is a complete solution that lets managers extract their conclusions out of the inspectors' job. The managers' following task is to provide the outcomes to their superiors. Businessmen managing workers like inspectors and managers are the ultimate customer of the project. These professionals are the ones hiring the service, which justifies dedicating a specific module to them. The next chapter, called Data Presentation, represents the step between managers and the customers of the service.

A case that may happen is that managers might not be able to use the website tools to provide the information that their superiors need. In this case, training for both inspectors and managers is required to make the service profitable for the customer's company.

In addition, personalized help can be given to customers regarding Data Management. No one knows how to use the website tools as the creating company. This service, though, comes at an additional price for the extra resources spent using a single client.

6.5. Data presentation

Presentation of data gathered and managed is the last module incorporated to the project solution. Its purpose is to give the minimum and necessary information to inform the client about the management of their assets.

Hence, Data presentation is meant to be a synthesis of the previous processes, avoiding a heavy load of technical details.

6.5.1. Presentation tools for managers & customers: Dashboard

Dashboard is the last website menu to be described, and the first one to appear when accessing the page (Figure 6.5.1). It contains a sample of each desired module, in order to have a quick overview of the state of work. Moreover, the Dashboard is completely interactive, allowing to access to each website menu by one click.

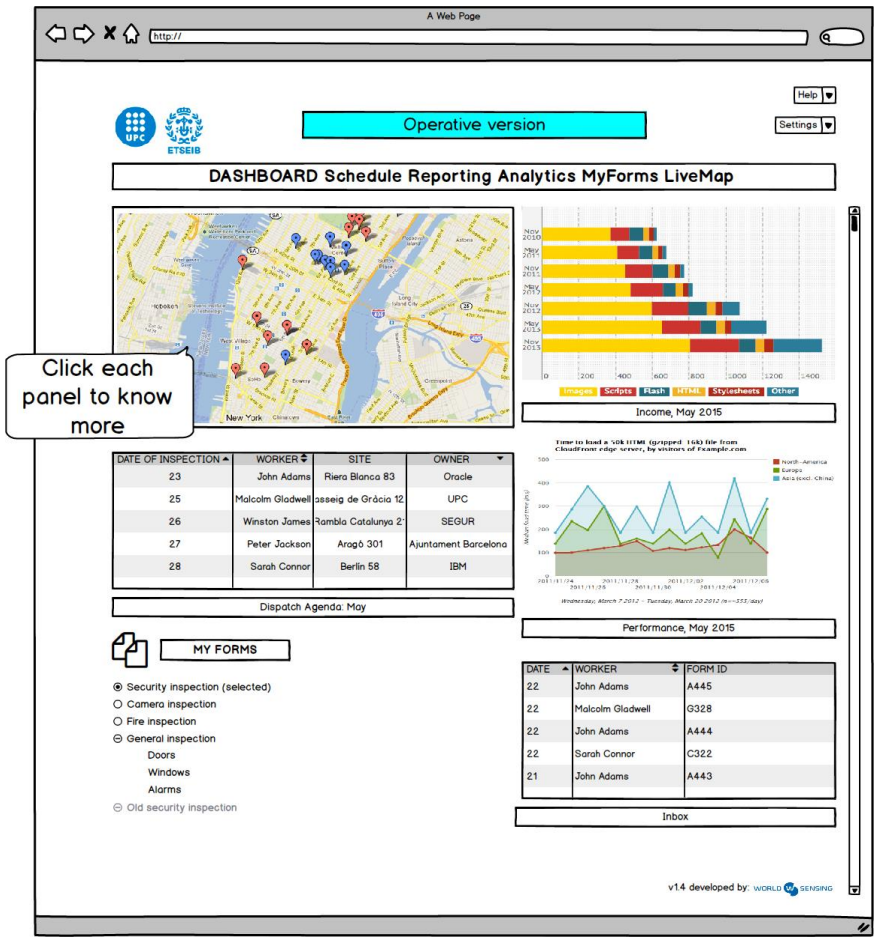

Figure 6.5.1 Website Dashboard full interface

Whether client wants to achieve the same knowledge as managers, they can always enter their account to consult Dashboard.

But it is default considered not to expect interaction between the final customer and the website at any time. For this reason, Dashboard can be downloaded to present the information shown in a given moment. Its design is customer oriented so the visualization of modules is clear and understandable. Moreover, Dashboards content can be edited through a Drag&Drop system, allowing to add or remove the needed graphs, data about the best workers or the list of forms currently used by the company to monitor their assets.

Since its list of features is quite simple, Figure 6.5.2 includes them all (again repeated in Annex D: Website list of features for a whole overview of the website product)

Dashboard	LiveMap	Asset location	
		Asset inspection	Date
			Inspector
			Site
			Quick dispatching
	Work orders	Calendar of monthly inspections	
	Performance	Analytics' graphs attaching	
	MyForms	List of current forms	
	Manager Inbox	Messages from Inspectors	
	Module management	Addition	Drag&Drop
		Visualization	Access to menu
		Deleting	
		Downloading	

Figure 6.5.2 Dashboard list of features

6.5.2. Data Presentation conclusions

Existence of Dashboard module is possible for 2 reasons:

- To give an overview of the whole EAM network the manager is working on.
- To serve as a marketing tool for customers to show in an attractive approach how the management of his good work.

The first point has a direct importance for the monitoring of assets, since it's the tool used to check their status, and taking actions to have an update on the life of assets, the mentioned inspections.

On the other hand, it is a juicy utensil for the customer to show to other members of the company that actions are being taken to improve assets' productivity. Commerciality of the product is a key factor to make it able to sell it. Once a need is created, the product find its niche to satisfy their customers. And to acquire client loyalty, a solid commercial campaign, plus a product that works plus attention for the customer are musts.

In the following chapters the implementation of the product and its business plan will be described, in order to achieve a successful selling strategy.

7. Financial estimations of the project

7.1. Introduction

Regarding the Project's costs, its total amount will be divided in two main blocks:

- The first segment references to the product definition, in other words, the work done in this memorandum. Hence, it compiles the tasks done by the author of the thesis, regarding the planning of the product from its conception to the start of its development.

Project description cost proposal will be divided in 3 different segments, as seen in Figure 7.2. Each segment corresponds to the responsibilities held by the members of the team. All proposals exposed in this thesis are expressed on a wage of earned dollars per hour of work:

- The first segment conforms the list of tasks performed by intern engineers in the project. Several tasks that have been undertaken by the interns without direct decision making are included in this list, such as market research. It has to be taken into account, to this sort of tasks a restrained wage is payed.

- The second segment refers to junior engineers, who are in charge of providing support tasks to the project leader. These sort of tasks are of high importance, for this reason they must be carried under supervision of product originators. In this case, wage compensation is raised due to added responsibility.

- Lastly, the third segment refers to the top responsibility in project realization, the project leader. This person is actually encouraged to translate customer requests into a useful service. Hence, because these sort of tasks engage a lot of responsibility, a higher wage it is exchanged to its impact into the project.

- The second division, since this project shows all the steps required to make the product become a reality, it also involves its development costs. Again, this proposal has taking into account the tasks made to estimate both mobile app and website costs, as we can see in Figure 7.3 and Figure 7.4. cost estimation has been realized with a combination of three different sources:

    - First of all checking budgets' examples shown by developers on the Internet.

    - The second source came from the company that pushed this project to become a reality. Most of the company is composed by programmers, so they could make an estimation of the involved costs.

    - Finally, several companies have been contacted, by asking a budget to develop each of these two tools (app & website).

As mentioned, project development wages are separated by responsibility. In both website and app, designers have taken part in all the decisions that may directly affect customers' interaction with the product. And there are also the developers, responsible to code all back and front end features.

Finally, it is to be stated that auxiliary costs such as energy expenditure have not been taken into account. Its contribution to the total budget it has been considered to not be relevant enough.

7.2. Project description costs

	Task	Days	Hours	Month	Intern [6$/h]	Junior [20$/h]	Senior [40$/h]
	EAM introduction	3	12	February	72	240	480
	Competence testing	14	56	February - March	336	-	-
	Market study	5	20	March	120	-	-
	Product definition	20	80	March - April	-	1600	3200
	Total planning phase	**42 days**	**168 hours**	**4 months**	**$528**	**$1840**	**$3680**
Project description	Project intro	3	18	May	-	360	-
	Market study	4	24	May	144	-	-
	Product development	3	18	June	-	360	720
	Product implementation	4	24	June	-	480	960
	Business plan	3	18	June	-	-	720
	Conclusions	2	12	June	-	-	480
	Bibliography	1	6	June	36	-	-
	Correction / Final touches	5	30	June	-	600	1200
	Total description phase	**25 days**	**150 hours**	**3 months**	**$180**	**$1800**	**$4080**
	Total	**67 days**	**318 hours**	**6 months**	**$12108 (no taxes)**		

Figure 7.2 Project description costs proposal

The total sum of the Budget comprises since the study of the Enterprise Asset Management world until the memorandum is finalized.

This lapse of time goes from mid-February until the last week of June. There is a lapse of time with no work at all, from mid-April to mid-May, due to a change of priorities inside the company.

The relationship between cost and time spent is shown in this segment, since we are counting the price on a fee-per-time structure. Cost is expressed in dollars in order to show it in the same currency as the project development (to be explained below).

Moreover, to have an overview of how time has been spent in the Project we can see that:

- A total of 130 hours have been spent in the prior stages to the product development. This includes studying the EAM solutions, its market size and also the introduction to the project. This amount represents a 41% of the total amount of time dedicated to the project.

- The product definition *per se* has required a total of 98 hours, almost the 31% of the time. It is curious to see how the technical aspect of an engineering project, which is theoretically the most important one, took a rather small fraction of the total amount of time spent.

- The rest of the time, 90 hours, the 28%, that have been spent in the project are used in the description of the implementation of the project (to be seen later), and the last touches of the thesis, such as extracting conclusions form the project writing, and other small details (bibliography, visual design, etc.)

To sum up, we can observe that the budget is directly related to the honorariums for each of the different engineers. Time is a fixed variable, so if the project leader earns twice as much as a junior engineer, its tasks costs are multiplied by two.

7.3. App & Website development budget

	Back end features	Days	Designer [75$/h]	Developer [60$/h]
App	Data storage	13	-	4680
	User Management	13	5850	4680
	Server-side logic	12	-	4320
	Data integration	13	-	4680
	Push	6	-	2160
	Versioning	12	-	4320
	Front end features	**Days**	**Designer [75$/h]**	**Developer [60$/h]**
	Caching	6	-	2160
	Synchronization	8	-	2880
	Wireframing	8	-	2880
	UI design	10	4500	-
	UI development	12	5400	-
	UI testing	10	4500	3600
	TOTAL [$]	**123 days**	**$56610 (no taxes)**	

Figure 7.3 App development budget proposal

	Division of features	Days	Designer [60$/h]	Developer [45$/h]
Website	Planning	6	2160	1620
	UX	8	2880	2160
	Visual design	28	10080	-
	Programming	54	-	14580
	Content support	7	-	1890
	Client training / documentation	3	-	810
	Testing & launch	12	-	3240
	TOTAL [$]	**118 days**	**$39420 (no taxes)**	

Figure 7.4 Website development budget proposal

First of all, it is to be stated that wages that both website and app designers & developers earn are indicative. The fees' examples are based on what is earned in several countries in both Europe (Spain) and North America (USA). Price is expressed in North American dollars since most of the IT world information comes from America rather than Europe. Moreover, the price to be considered is in the final cypher, the one provided by asking to 3rd party developers.

As we can see, the difference between the app costs and website costs it is quite remarkable. Apps development is kind of a newer concept than websites, and we currently live in its peak.

Moreover, common knowledge regarding app costs is reduced, since most of apps in the market are leisure oriented. Development of an enterprise solution satisfying all requested features have a direct implication into the project cost. The last part to consider is the total sum of the project, and its separation between the project originators and external companies' contribution to it.

7.4. Project costs' conclusions

To have an estimation of the whole project cost, we come with the sum of the 3 main expenses. Due to both app and website are developed by an external company, taxes must be included on their services. The percentage added is related to these type of activities in the developing country, which means a 21% of its total.

- Project description: $12,108.00
- Mobile phone app: $56,610.00 (no taxes) → $68,498.10
- Website: $39,420.00 (no taxes) → $47,698.20

To sum-up, the official cost of the EAM solution developed in this project comes to $128,304.30, almost $130,000 American dollars.

This figure depends largely on the development of the app and website, which involves a bigger team than the one writing the project description (one person who has worked with three different degrees of responsibility). In addition, recurring to 3rd parties always involves a higher investment, If the company who develops the project also develops the products, the capital investment needed is not so high.

For this project to become a worthy business, the next step it is to describe its commercial implementation on the market. Even though the featured service is not provided by a high recognition company, its price must ensure profitability of the investment in this technology.

8. Business strategy

8.1. Introduction

This chapter will show us the decisions made about the product selling campaign. In order to come with a final decision, our current market trends and topics have been analyzed. Such as both companies and their payment strategy (stated in Chapter 5: Prior Art). The outcome is presented in Figure 8.1 as a table comparing different pricing methods:

Service/Company	Features	Pricing [$/account]
GoCanvas Professional	Back end & Data management, no support	31/month
DataField Premium	Back end & Front end, no support	99/month
Prontoforms account	Back end & Front end, extra support	25/month
IBM Maximo Asset Management	Front end & support	5500/year
Oracle E-Business Suite	Front end & support	4600/year

Figure 8.1 EAM solutions pricing options

Nowadays, there are two main tendencies regarding Asset Management solutions:

- On one hand, there are companies offering a monthly fee per account ordered. Although the service's liberty of use is high, given support is almost none. Smaller companies such as GoCanvas or DataField offer this type of solution. Price ranges from $10 to $100 per license and per month

- On the other hand, market's big players offer integral solutions, using what it is commonly known as a pack. These packs usually come with a yearly software license, and 24/7 support to customers. Nevertheless, to order an integral solution there must be a minimum amount of licenses ordered by customer (minimum 10). IBM or Oracle's solutions are inside this group of powerhouse companies.

8.2. Commercial strategy chosen

In case of this project's solution, the approach to follow is a combined payment method. The goal is to give as much liberty to clients as possible, but providing all necessary support in case it is needed. Active support guarantees customer's satisfaction, and at the same time, is the feature that produces more profitable benefits.

For the aforementioned reasons, our solution will consist in two aspects:

1. Offering a pack including both app and website licenses. Our solution will cover both Back End and Front End blocks of the EAM world. The basic pack will consist of 20 licenses of the cellphone app, plus one website license for the manager (inside manager can create inspector accounts in order to dispatch work orders or tracking performance). This combination is offered for $500/month (each account per separate would be $24/month approx.)

2. Offering a consultancy service for an extra fee. In this case, consultancy staff can be necessary in order to analyze data in the correct way to come up with useful reports. Consultancy support would be 24/7 for a total of $2000/month

This way, if clients have the necessary skills to analyze large amounts of data, their solution will cost in a similar way to smaller companies services. But in case they don't have the necessary time or resources to analyze acquired data, a member of our company will take care of it.

Needless to say, hiring a consultant to provide support to customers is an important cost for the Company. For this reason, consultancy service fee is a way to transfer companies' staff wages to the client.

8.3. Project profitability

Once there is a strategy to sell the product, it is necessary to check which benefits this project can provide. For this reason, we will simulate a 5-year possible scenario on the financial point of view.

To check the service profitability, 2 very famous values will be calculated; the Net Present Value (NPV or VAN in Spanish), and the Internal Rate of Return (IRR or TIR). In Figure 8.4 we can check the results of calculations.

To get to those values, though, several hypothesis have been used:

- First, in year zero the initial investment of $130,000 approximately is considered. Moreover, consultants' wages are added (project leaders' fee is already considered in initial investment)
- Number of packs sold is multiplied by 2 every year. This factors could mean two things; that a satisfied customer wanted more licenses, or that new customers purchased the service.
- Last, considered costs are three:
    - Project leader wage to be added from Year 1 and on
    - Consultant (or consultants since Year 2) wage for customer support
    - Maintenance cost of both app and website by the developing company

To sum-up, Figure 8.3 and Figure 8.4 represent this case and finally show the expected results.

Time	Expenses [$/year]		Number of customers	Fee [$/month]	Income [$/year]
Year 0	Initial investment + project leader	130000	1	$500 for 20 apps and 1 website license	30000
	1 Consultant	25000		$2000 for support	
	Service maintenance (1 customer)	1000			
Year 1	Project leader wage	30000	2	$500 for 20 apps and 1 website license	60000
	1 Consultant	25000		$2000 for support	
	Service maintenance (2 customers)	1500			
Year 2	Project leader wage	32000	4	$500 for 20 apps and 1 website license	120000
	2 Consultants	50000		$2000 for support	
	Service maintenance (2 customers)	2000			
Year 3	Project leader wage	35000	8	$500 for 20 apps and 1 website license	240000
	2 Consultants	55000		$2000 for support	
	Service maintenance (2 customers)	2500			
Year 4	Project leader wage	38000	16	$500 for 20 apps and 1 website license	480000
	2 Consultants	58000		$2000 for support	
	Service maintenance (2 customers)	3000			
Year 4	Project leader wage	40000	32	$500 for 20 apps and 1 website license	960000
	2 Consultants	60000		$2000 for support	
	Service maintenance (2 customers)	4000			

Figure 8.3 Expenses & Incomes considerations

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Income [$]	30,000	60,000	120,000	240,000	480,000	960,000
Expenses [$]	-156,000	-56,500	-84,000	-92,500	-99,000	-104,000
Benefits before taxes [$]	-126,000	3,500	36,000	147,500	381,000	856,000
Taxes (21%) [$]	-26,460	-735	-7,560	-30,975	-80,010	-179,760
Cash flow [$]	-152,460	2,765	28,440	116,525	300,990	676,240
Accumulated Cash flow [$]	-152,460	-149,695	-121,255	-4,730	296,260	972,500
NPV [$]	**316.030,79 $**					
IRR	**32%**					

Figure 8.4 Project financial profitability

8.4. Business strategy conclusions

Though charging quite a high fee to customers, paying back the investment in the development of the project takes time.

As we can check in Figure 8.4, the return on the investment happens during Year 4, which means that no small company might be able to handle to create this product.

Moreover, presence of consultants in the company add costs on a yearly basis. Their wage must be covered by several customers in order to make their presence in the company profitable.

But if a company might be able to face this costs, and to have patience gathering more customers, results totally pay off.

In the last year for example, expected income is close to $1 million, by having 32 packs sold, or the equivalent of 32 managers and 640 inspectors using the described solution. It seems a feasible goal, since there are lots of companies with thousands of employees working as inspectors that may be benefited from this solution.

An inspector can be a security company member checking shopping mall fire extinguishers for example. Taking a look at the amount of assets that private companies may want to monitor, there is a potential customer base to reach.

9. Project implementation

9.1. Introduction

Using the same approach as the Project costs calculation, its time implementation has been divided in two blocks: project description and project development.

In both Figure 9.2.1 and 9.2.2 we can see task distribution of each block. These charts represent the amount of days spent in each task, as well as its place in the year timeline (by month).

Moreover, a couple diagrams have been drawn to see this timeline. In Figure 9.2.2 the amount of tasks done during the memorandum are represented. An in Figure 9.3.2 we can observe both mobile app and website monthly development. In both cases, the approach to see the evolution of the project is the Gantt technique (shown in horizontal).

9.2. Project description

	Task	Days	Hours	Month
Project description	EAM introduction	3	12	February
	Competence testing	14	56	February - March
	Market study	5	20	March
	Product definition	20	80	March - April
	Total planning phase	**42**	**168**	**3 months**
	Project intro	3	18	May
	Market study	4	24	May
	Product development	3	18	June
	Product implementation	4	24	June
	Business plan	3	18	June
	Conclusions	2	12	June
	Bibliography	1	6	June
	Correction / Final touches	5	30	June-July
	Total description phase	**25**	**150**	**3 months**
	Total	**67**	**318**	**6 months**

Figure 9.2.1 Time distribution chart of project description

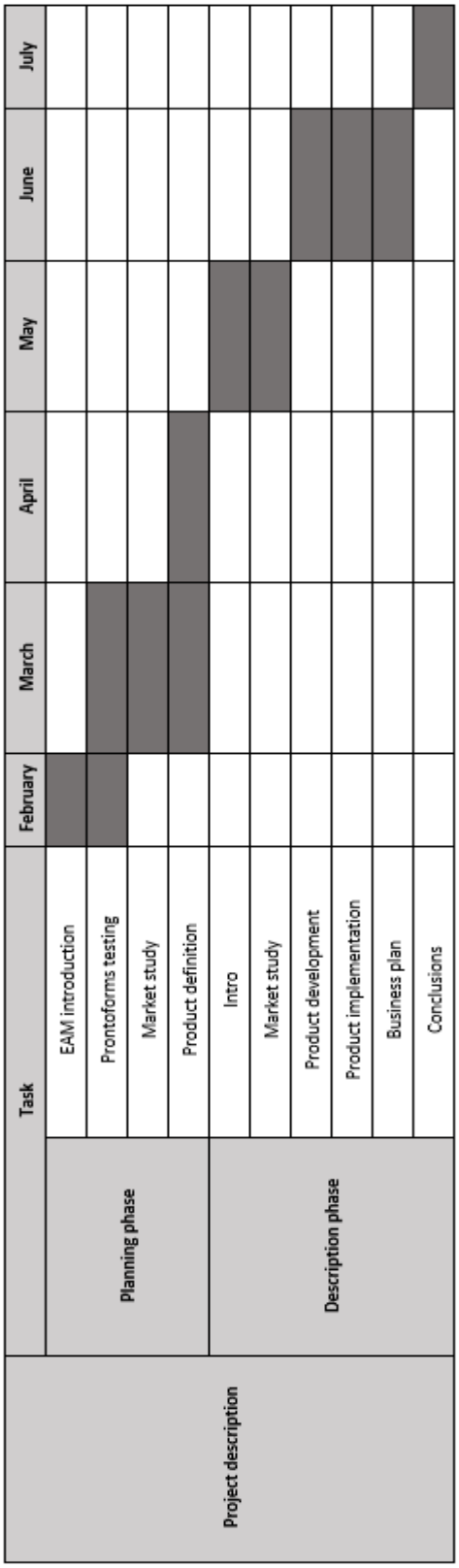

Figure 9.2.2 Gantt chart of project description

9.3. Project development

		Task	Days	Month
Project development	**App back end**	Data storage	13	July
		User Management	13	July - August
		Server-side logic	12	August
		Data integration	13	August - September
		Push	6	September
		Versioning	12	September - October
	App front end	Caching	6	October
		Synchronization	8	October
		Wireframing	8	October - November
		UI design	10	November
		UI development	12	November - December
		UI testing	10	December
	Total app		**123 days**	**6 months**
	Website Planning	Planning	6	July
	Website Design	UX	8	July
		Visual design	28	July - August
	Website Development	Programming	54	August - September - October
		Content support	7	October - November
		Client training & documentation	3	November
	Website Testing	Testing & launch	12	December
	Total website		**118 days**	**6 months**

Figure 9.2.2 Time distribution chart of project development

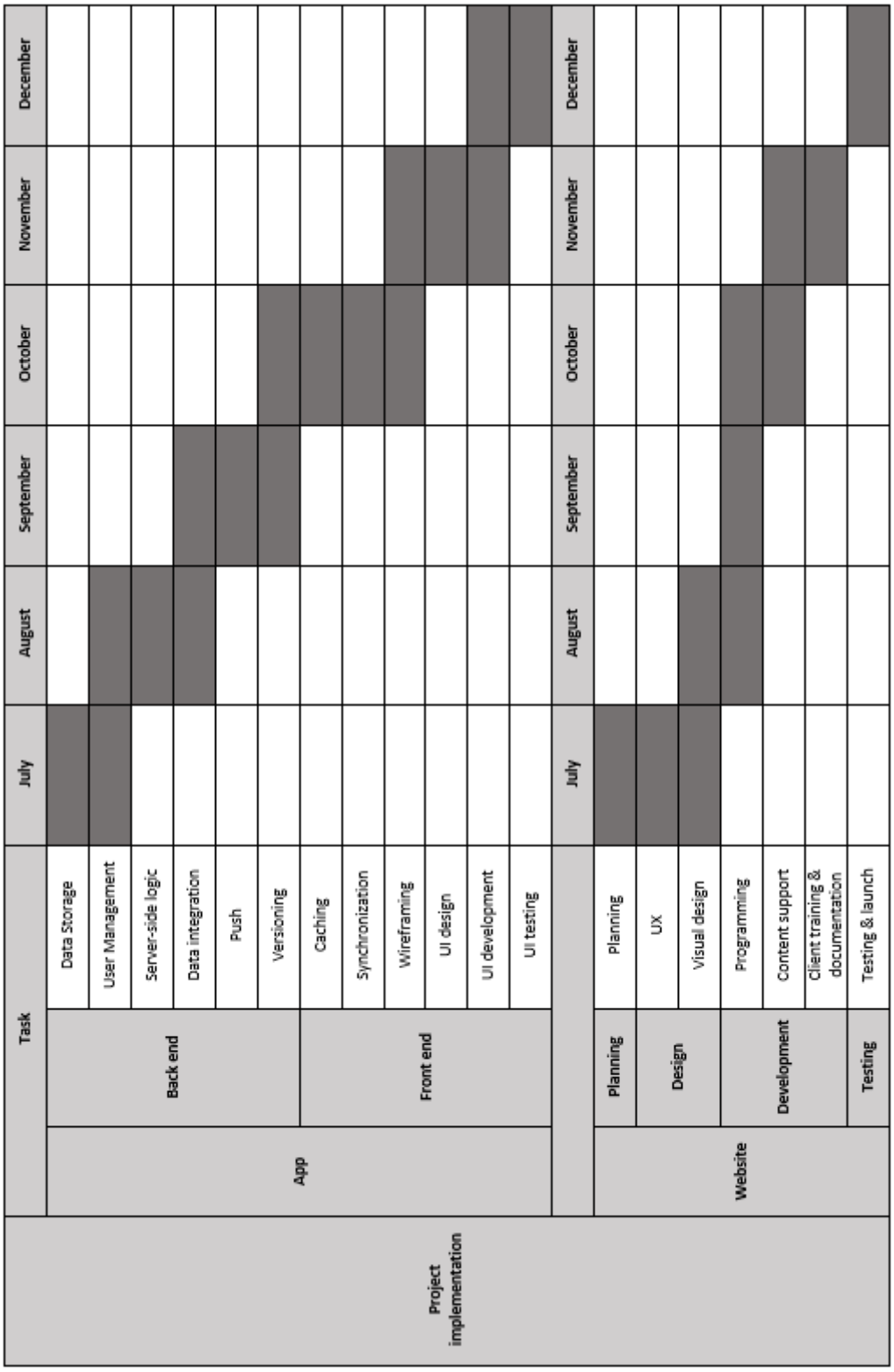

Figure 9.3.2 Gantt chart of project development

9.4. Project implementation conclusions

Expectations in the implementation of the product are fairly uncertain. On the one hand, the period of time spent in the project description is accurate since all tasks were registered while working on them.

However, development of app and website cannot be trusted totally by the dates stated above. These dates are a guide provided by the developing company (a 3rd party) when asking them for a budget to make both website and app.

Estimations of the website development time were based in the following structure (% of the total time to be spent):

- Research and planning → 5%
- Solution design → 5%
- Website design → 25%
- Back end development → 30%
- Front end development → 15%
- Content entry → 8%
- Testing → 10%
- Go-live → 2%

These percentages differ to the ones stated in the project description. Most of the brainstorming and planning are done by the project manager. The website's developing company is given all requested features, having to spend less resources in planning and more into coding actually.

However, % of tasks spent on the app were not facilitated. Known information is extracted from developers sharing their information on the Internet. But the main idea was to provide both website and cellphone app at the same time.

The total amount of time spent on the tools development is resumed in 120 working days approximately. Translated in the calendar involving weekends and other festivities, its sum comes to 6 months of development of the project. Adding that to the project description, results pay its reward after 9 months of work in an 11 month wingspan: from February until December of the year 2015.

10. Environmental impact

As its name states, the goal of the project is to enable inspectors to fill forms using a cellphone device. What does this imply? That each time the mobile app is used to monitor an asset status, generous amounts of paper are being saved to acquire data.

Hence, this chapter is one of the strong points that the project solution offers. These paper savings are especially beneficial when big companies are customers using this technology. Another variable that will be analyzed is gas consumption to visit each site to inspect.

To measure the amount of paper saved, we proceed to create a savings calculator (Figure 10.1). This chart enables to fill several fields regarding the company making inspections: the number of inspectors, the amount of forms filled by each one, how many paper sheets is a form made of in average, etc.

To have an example, we have filled a customer company made by 50 inspectors filling 8 inspections each one, per day.

Field	Amount	Field	Constant
# of inspectors	50	Working months per year	10
# of forms filled [per inspector / per day]	8	Price of 100 sheets of paper [$]	1
# of pages per form	4	Consume of gasoline [gallons/mile]	15
# of working days per month	20	Price of gasoline [$/gallon]	2,96
# of photocopies made [per form]	1		
# of miles between inspections [per inspector / per day]	2		
Amount of forms filled per month	8.000		
Amount of paper used per month [paper sheets]	64.000		
Amount of paper used per year [paper sheets]	640.000		
Monthly paper expenditure [$/month]	**640**		
Yearly paper expenditure [$/year]	**6.400**		
Amount of gasoline consumed per month [gallons]	12.000		
Amount of gasoline consumed per year [gallons]	120.000		
Monthly gasoline expenditure [$/month]	**35.520**		
Yearly gasoline expenditure [$/year]	**355.200**		

Figure 10.1 Paper and gasoline expenses calculator

Several prices has been used as reference, such as paper price, car consumption and price of gasoline.

Results are quite obvious:

- Every year this company can save up to $6400 by using the paperless solution. And moreover, this has a consequence in paper weight expenditure. We can come up with a number of trees saved by using Equation 1:

$$\frac{640.000\ paper\ sheets}{year} * \frac{80\ grams}{1\ paper\ sheet} * \frac{1\ kilogram}{1.000\ grams} * \frac{1\ tree}{15.000\ kilograms} = 3{,}413\ trees/year$$

Equation 1. Number of trees that may be saved per year

An amount ranging between 3 to 4 trees could be saved by a single company each year using this approach. Given the high amount of people still using paper sheets to fill their forms, there is a lot of room for improvement regarding natural resources abuse. Entire woods can be saved by using a more efficient, environmental-friendly technology.

To show it in a more useful variable, a mature tree is able to absorb 22 kilograms of CO_2 each year and transform them to roughly 120 kilograms of O_2. This way we can observe how much CO_2 can these saved trees handle (Equation 2)

$$\frac{3{,}413\ trees}{year} * \frac{22\ kilograms\ CO2}{tree} = 75{,}1\ kilograms\ CO2/year$$

Equation 2. CO_2 absorption of saved trees per year

- On the other hand, there is another factor that contributes to environmental damage, which is fuel consumption. Use of cars to mobilize inspectors from one site to the next one means a high emission of CO_2 to atmosphere. Equation 3 will show the total amount of emissions:

$$\frac{120.000\ gasoline\ gallons}{year} * \frac{8{,}89\ grams\ CO2}{1\ gasoline\ gallon} * \frac{1\ kilogram\ CO2}{1.000\ grams\ CO2} = 1066{,}8\ kilograms\ CO2/year$$

Equation 3. CO_2 emission of inspectors' cars per year

This fact is quite more pessimistic, though. Though we are saving almost four trees yearly by not wasting paper, inspectors' mobilization would require almost 50 trees to absorb the amount of CO_2 they have emitted with their vehicles.

A possible solution to this cause would be to make urban site inspectors use public transportation to move. The comfortability of carrying a cellphone instead of a package of forms and pens to write can help to change their mindset.

Conclusions

First half of conclusions will be dedicated to check if Project goals have been fulfilled. Second half will come with outcomes regarding the development of the project per se.

Project thesis was born as a solution to several market needs. Its purpose then, was to include features to satisfy customers' necessities stated during the market study. We can consider that the project is a success regarding client satisfaction, since all asked aspects were considered.

The first of the goals was to obtain visibility and control over owned assets. Development of a data acquisition solution solves this necessity, as inspectors visit assets periodically.

Moreover, another customer goal was to be able to manage data coming from inspections. In this case, data management serves more as a mean than a goal. It is a way to provide control over assets, in order to increase their useful life. Asset's life elongation was a project goal, not a customer one. Hence, both customer and project manager intentions are satisfied.

On the other hand, expectations of making inspection process more agile is totally achieved. Usage of cellphones to obtain data and communication to managers via Internet, drastically reduces involved time in conventional inspections.

Last but not least, goal of tracking inspectors' performance is accomplished too. In this case, use of mobile phones is a double solution of the project: on the one hand it allows them to perform inspections. On the other hand it collects information regarding phone's user. Inspectors' info is not acquired secretly; when filling a form it is requested to register their location and time spent, in order to be able to send it finished.

Next half of conclusions is related to the creation of this project, its development.

Solutions' complexity is high. There is an abysmal difference between app and website development for leisure, than development for an enterprise need. Its description is complicated, and it feels like more information should be required in several chapters, especially the technical ones.

For this reason, this project's scope was to describe solutions behavior in general. Specific explanation of each single feature needs a deeper project, which should come in a following iteration. This project scope can be enough for the app & website developing company to start working. But service's entire description should be composed both by project manager's information and developing company data.

Another conclusion is that project cost calculation has overwhelmed all made expectations. In a raw version of the document, solution development was estimated a total of $20,000 approximately. This figure has been multiplied by 7, and it may even go higher when the project is almost finished. This example shows that solid project planning is needed before entering its development, in order to avoid surprises. Therefore, this thesis represents a quite detailed calculation of project development.

Moreover, price setting comes into discussion, regarding if it's expensive or cheap. Price should be an amount related to the value of the service given. Taking into account that project's service offers solutions for all EAM modules, it should be contemplated as fair that its price is higher than partial solutions developed by the competence.

Lastly, it is to be highlighted the implementation of the project in the time frame. As it was described in its chapter, time investment is different in product description than in product development. It is a positive outcome that this document represents a big portion of time spent in market research, competitors' comparison, and features description.

However, the short amount of time used by app and website developers is underrated. If the company has never worked in a similar project, they will need time to adapt to this type of project they have been hired. And they will also have to plan the amount of resources to destine to this product. In consequence, project development time will be substantially longer than estimated.

Special thanks

I'd like to spend the following content to the people who made this project transform from an idea into a reality.

First of all, I'd like to thank the company who represented the frame for the project development, Worldsensing. The product described in the thesis is actually into development, and I was the person asked to make an important client request turn into a new product of the company. Moreover, I would like to thank them since many aspects of the project could be included to this document thanks to their explanation and introduction to me into this Asset Management world.

I'd like to thank specially to Ignasi Vilajosana, Company CEO and my boss. He trusted an intern like me to handle this task, and guided me during the whole process of the project description. In addition, he became a big source of relevant information to include in the content of the project in order to create a solid service, what is known in business as Software as a Service (SaaS).

Furthermore, I'd like to say thanks to Manel Toril, the Worldsensing employee who works with me the most and helped at any moment. Even though he has many other duties to take care, its contribution was daily and key. Manel helped me to choose the most optimal solution in every crossroad of the project, with the goal to make a professional and salable product. His expertise in sales had a major impact in the later block of the project, the product implementation.

Last but not least, I'd like to thank professor Lázaro Cremades for his constant guidance during the project writing. I came into contact with him given his knowledge in the field of project management, exactly the scope I wanted to give to this work. Hence, we did have a similar vision and Lázaro provided me support of the content needed to deliver a complete document.

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Annexes

Annex A: Gartner Magic Quadrant evaluation criteria

The following Annex is dedicated to the evaluation of EAM solutions' big players. Consulted documentation was Gartner's Magic Quadrant, a company specialized in market evaluation of their companies.

A number of different factors are considered in order to be a big player, such as:

- ✓ **Market Understanding:** The ability of the vendor to understand buyers' needs and translate these needs into products and services. Vendors that show the highest degree of vision listen to and understand buyers' wants and needs, and can shape or enhance those wants with their added vision.
- ✓ **Marketing Strategy:** A clear, differentiated set of messages consistently communicated throughout the organization, and externalized through the website, advertising, customer programs and positioning statements.
- ✓ **Sales Strategy:** The strategy for selling products that uses the appropriate network of direct and indirect sales, marketing, service and communication affiliates that extend the scope and depth of market reach, skills, expertise, technologies, services and the customer base.
- ✓ **Offering (Product) Strategy:** A vendor's approach to product development and delivery that emphasizes differentiation, functionality, methodology and feature set as they map to current and future requirements.
- ✓ **Business Model:** The soundness and logic of a vendor's underlying business proposition.
- ✓ **Vertical/Industry Strategy:** The vendor's strategy to direct resources, skills and offerings to meet the specific needs of individual market segments, including verticals.
- ✓ **Innovation:** Direct, related, complementary and synergistic layouts of resources, expertise or capital for investment, consolidation, defensive or preemptive purposes.
- ✓ **Geographic Strategy:** The vendor's strategy to direct resources, skills and offerings to meet the specific needs of geographies outside the "home" or native geography, either directly or through partners, channels and subsidiaries, as appropriate for that geography and market.

Representation of Magic Quadrant is expressed in Figure A.1. The best player is considered a “leader” since they both have the highest completeness of vision and ability to execute it. As we can see, IBM is the only leader of the industry, and the go-to company to have a reference to create our EAM solution.

Figure A.1 Gartner Magic Quadrant for Energy and Utilities Enterprise Asset Management Software

From Gartner's Quadrant, selected companies were the leader (IBM), the visionare (SAP) and the best rated competitors (IFS, Oracle). There is an exception by taking Infor before Schneider's solution. The reason is that Schneider is specially strong in Data Acquisition, and Infor is more into Front-End, like the rest of players.

It was considered that due to Data Acquisition was going to be using cellphones (a smaller company solution), Schneider's inputs wouldn't be that helpful.

Figure A.2 is a chart with a sum-up of the selected companies. Some of the objective criteria stated by Gartner's evaluation is included. Nevertheless, consideration of solutions' originality or or market understanding is not evaluated here, trusting Gartner's criteria.

Company	Location	Global size [$ billion]	World reach	Solution focus
IBM	USA	100	Global	Cloud & Smart infrastructure
				SaaS offering
				Predictive maintenance analytics
SAP	Germany	22	Global	ERP integration
				Energy & utilities
IFS	Sweden	0.4	Everywhere except North-America	ERP integration
				Maintenance & construction
Oracle	USA	38.3	Global	ERP integration
				Manufacturing, energy & utilities
Infor	USA	3	North America, Australia & New Zealand	Manufacturing , Government
				Water solutions

Figure A.2 Front end main players facts and figures

Annex B: App list of features

The following Annex is dedicated to state all included features in the app service. It is a support to the content included in chapter 6.2: Data Acquisition. Again, in Figure B.1 we have a sum-up of each app segment to describe. Later on, from Figure B.2 to Figure B.8 all features are shown following the app dock order.

This list is a guide for the app developing company in order to have an overview of the specifications to include in the product.

However, this Annex is not necessary to have a complete vision of the service to create. Constant communication between Project managers and 3rd Party developers will be kept from July 2015 until December 2015 to ensure they develop what is requested.

NewForm	Inbox	Outbox	MyCalendar	Settings	Inspector performance	Other features
Create form	Import of files	Submission of forms	Import of files	Choose language	Amount of forms filled	App download
Select form	Edition of forms	Edition of forms	Visualization of files	Account details	Status of inspector	Performance
File import	Form search	Form search	Form search	Contact	Comparison of performance	App version
Fields filling	Order of forms	Order of forms	Order of forms	Graph quality	Presentation of performance	Branding
Non-editable		Storage of forms		Help		Security
Submission				Feedback & suggestions		
Auxiliary						

Figure B.1 High level list of app features

New form	Create form	Dispatched	
		Choose from templates	
	Select form	From Inbox	
		From templates	
	Fields	Input system	Alphanumeric (keyboard)
			Multi-option
			Yes/No
		Support	Take a picture
			Record video
			Record audio
			Scan barcodes
			Scan QR
			Introduce signature
			Basic calculator
	Non-editable	Worker performance	GPS coordinates
			Day and hour
	Submission	Format	HTTP
			PDF
			Word
		Destination	Mail direction
			Cloud storage account
	Auxiliary	Slide to move between pages	

Figure B.2 List of features to include in New form menu of the app

Inbox	Import of files	HTML	
		PDF	
		CSV	
	Edition of forms	Delete	
		Hide	
		Download	
	Form search	Input	Alphanumeric
	Order of forms	Chronological	Descending (newest first)
			Ascending (oldest first)
		By page	Ascending (page 1 first)

Figure B.3 List of features to include in Inbox menu of the app

Outbox	Submission of forms	Automatic when Wi-Fi / 3G access	
		Manual	
	Edition of forms	Delete	
		Hide	
	Form search	Input	Alphanumeric
	Order of forms	Chronological	Descending (newest first)
			Ascending (oldest first)
		By page	Ascending (page 1 first)
	Storage of forms	Always	
		When Wi-Fi / 3G off	

Figure B.4 List of features to include in Outbox menu of the app

MyCalendar	Import of files	HTML	
		PDF	
	Visualization of files	HTML	
		PDF	
	Form search	Input	Alphanumeric
	Order of forms	Chronological	Descending (newest first)
			Ascending (oldest first)
		By page	Ascending (page 1 first)
		By state	Descending (To do first)
			Ascending (Done first)

Figure B.5 List of features to include in MyCalendar menu of the app

Settings	Choose language	English	
		Spanish	
		Catalan	
		French	
	Account details	Username	
		Password	
	Contact	Phone number manager	
		Phone number technical support	
	Graphic quality	Audio	High (camera MP)
			Medium (70% camera MP)
			Low (40% camera MP)
		Video	1080p
			720p
			480p
	Help	FAQ	
		Tutorials (link to website)	
	Feedback & suggestions	Alphanumeric input	
		Multi-option answer	

Figure B.6 List of features to include in Settings menu of the app

Inspector performance	Amount of forms filled	Per time	Week
			Month
		Per type of form	
	Presentation of performance	Histogram	
	Comparison of performance	With rest of company	
	Status of inspector	Per amount of forms filled	

Figure B.7 List of features to include regarding Inspectors' performance in the app

Other features	App download	From private link
		From Google store
	App version	Android
	Branding	Addition of logo
	Security	Internet data encryption (2048 bit SSL)

Figure B.8 List of features non classifiable in any other menu of the app

Annex C: App mock-ups

This Annex is dedicated to visually represent the app product. Although this project tried to describe the app service in the easiest words to understand, it may not be enough. For this reason, a series of mock-ups were designed to have an idea of what is expected.

Several fragments of the mock-ups have been shown during the memorandum. This section is dedicated to fully show them. All mock-ups were developed using Balsamiq software (free to use)

A point to state is the color legend of the mock-ups. In blue we can check the link between content from one menu to another one. And there are also several clouds that explain in a few words what is that feature about.

Figure C.1 to Figure C.8 is the list of mock-ups developed regarding the app service.

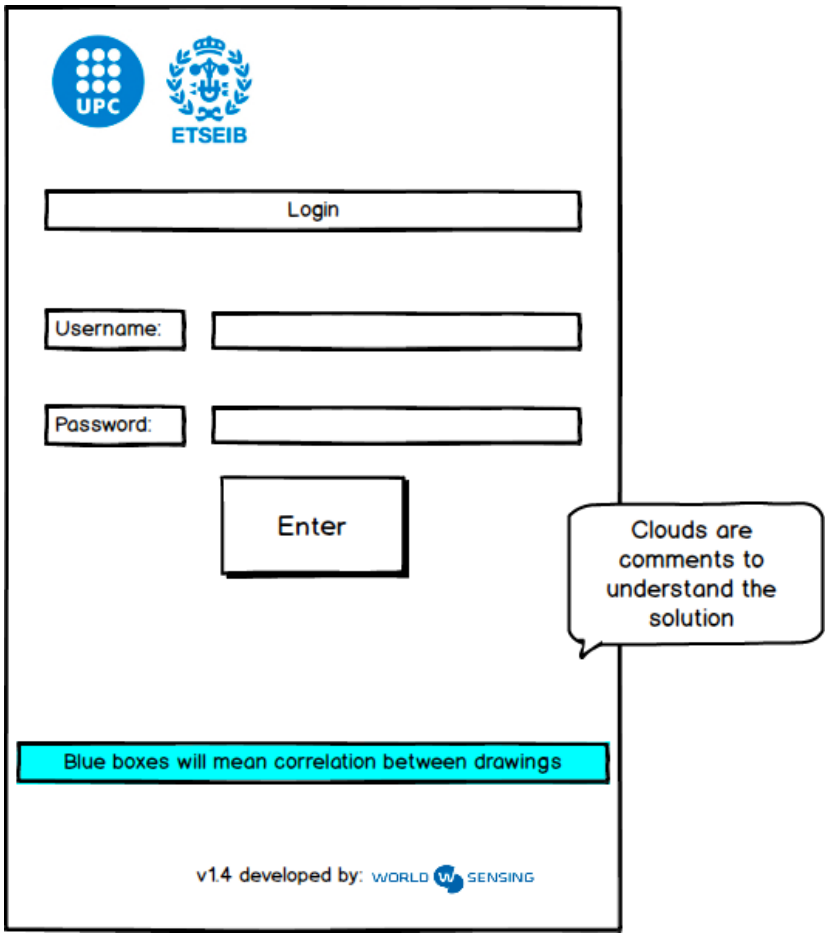

Figure C.1 Login menu of the app

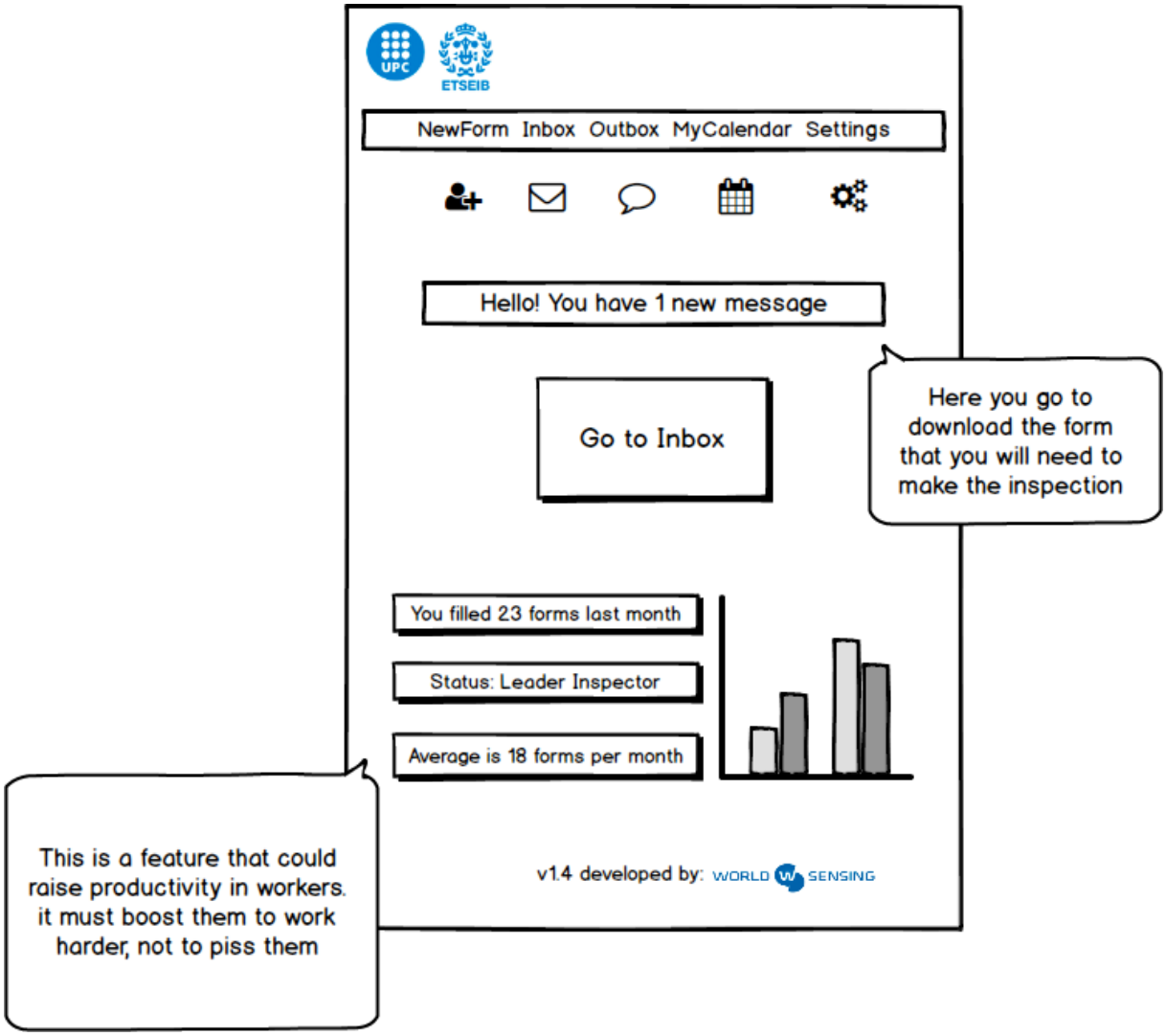

Figure C.2 Main menu of the app

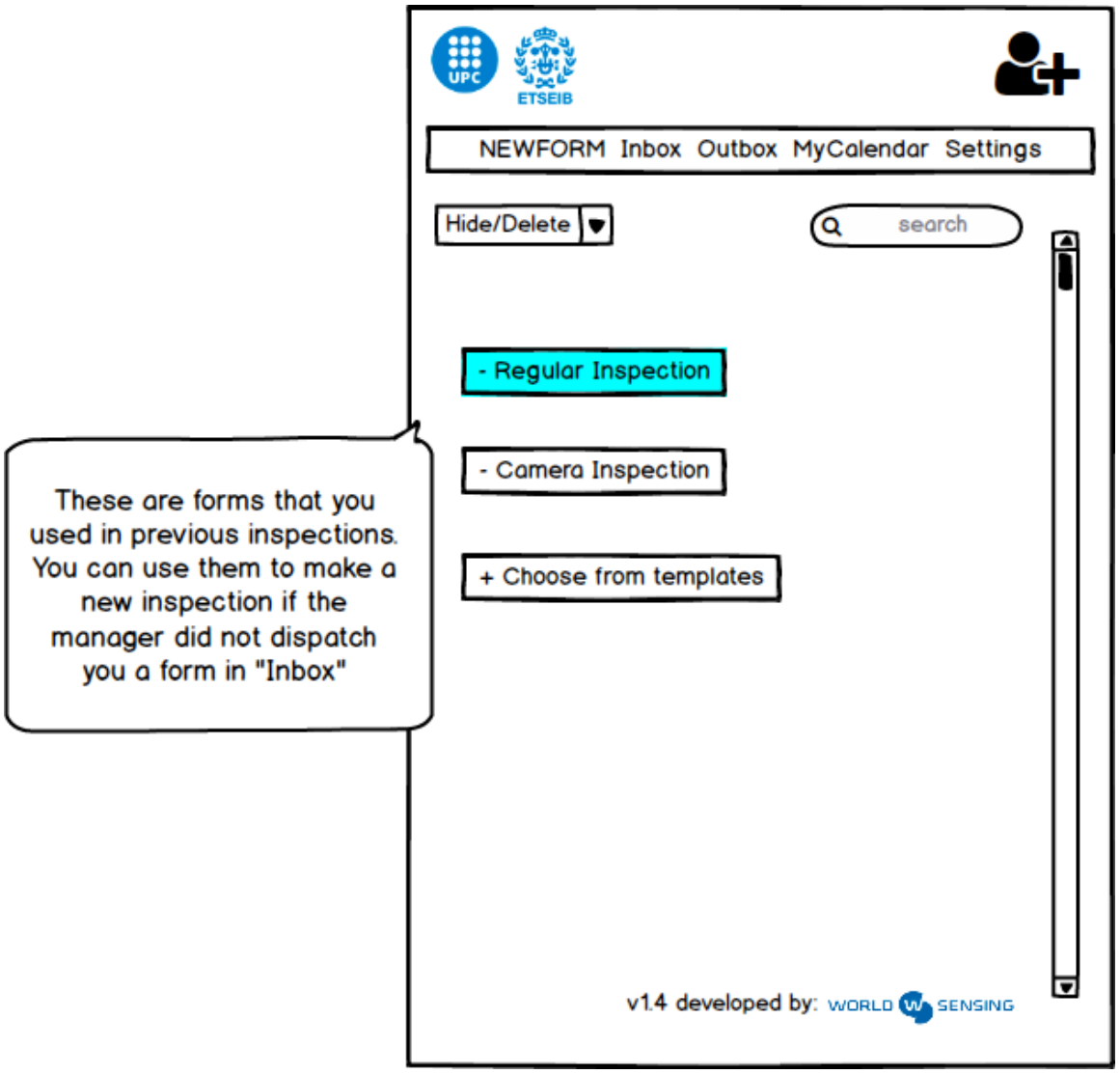

Figure C.3 New Form menu of the app

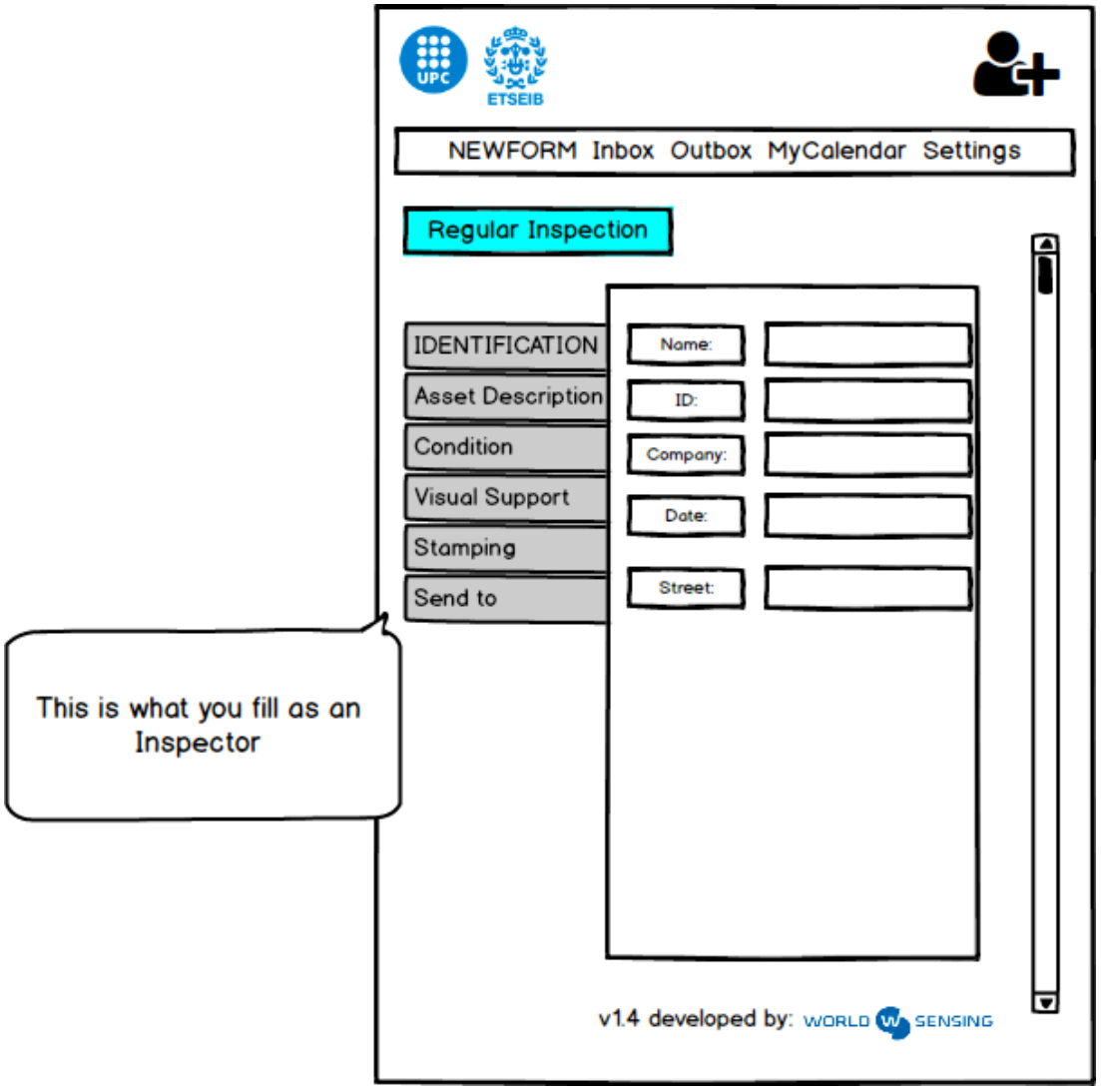

Figure C.4 New Form filling

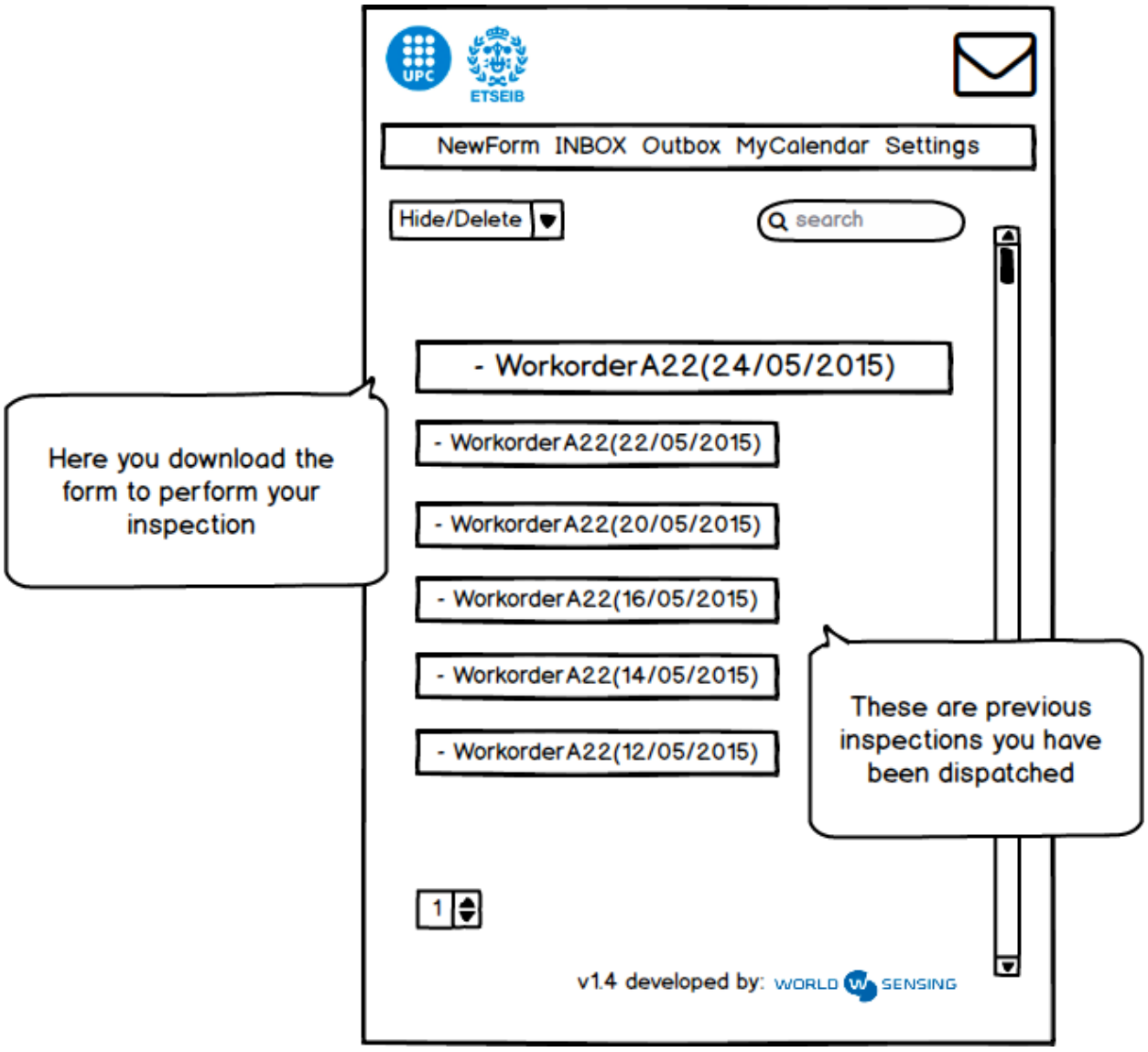

Figure C.5 Inbox menu of the app

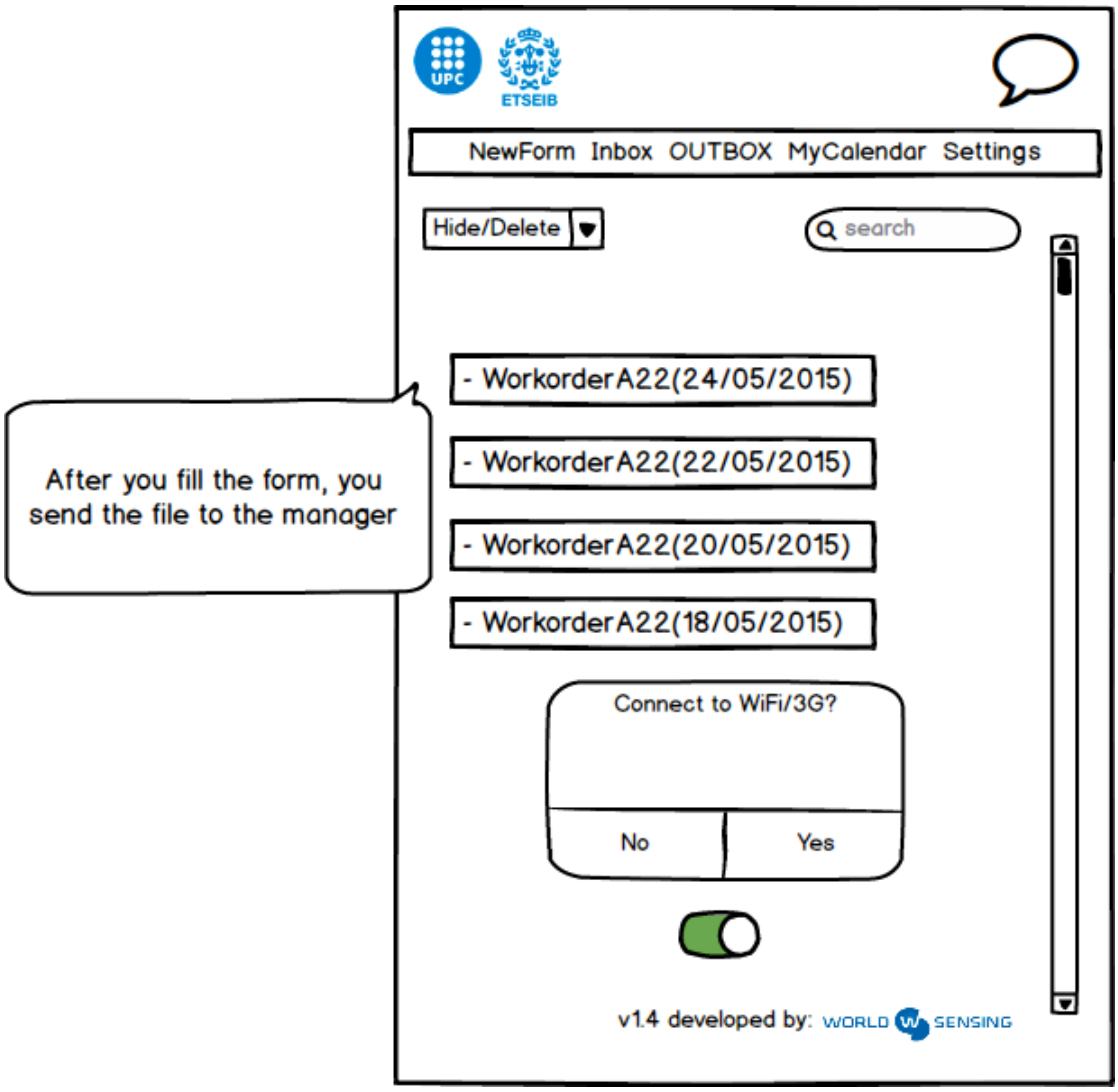

Figure C.6 Outbox menu of the app

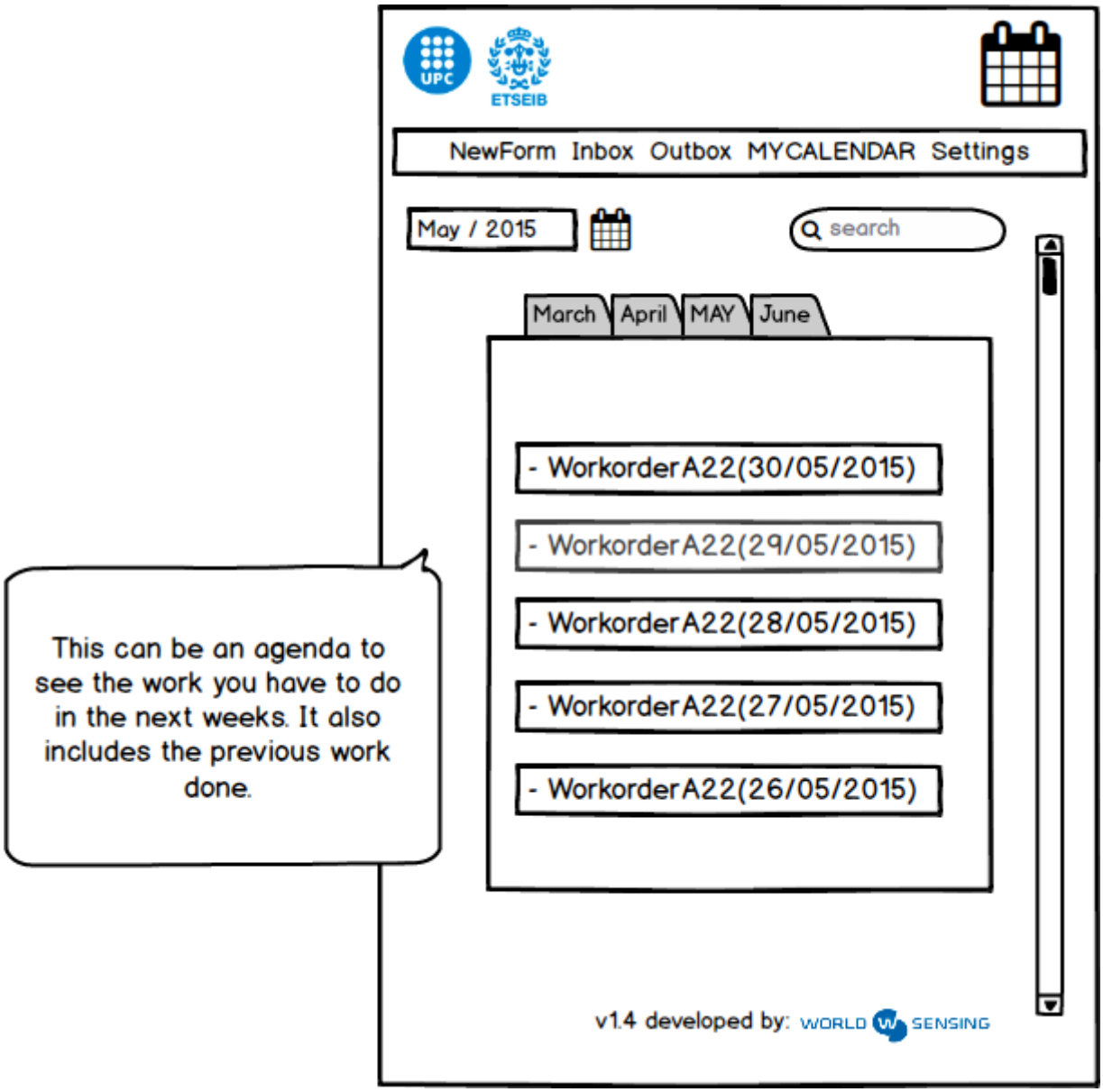

Figure C.7 MyCalendar menu of the app

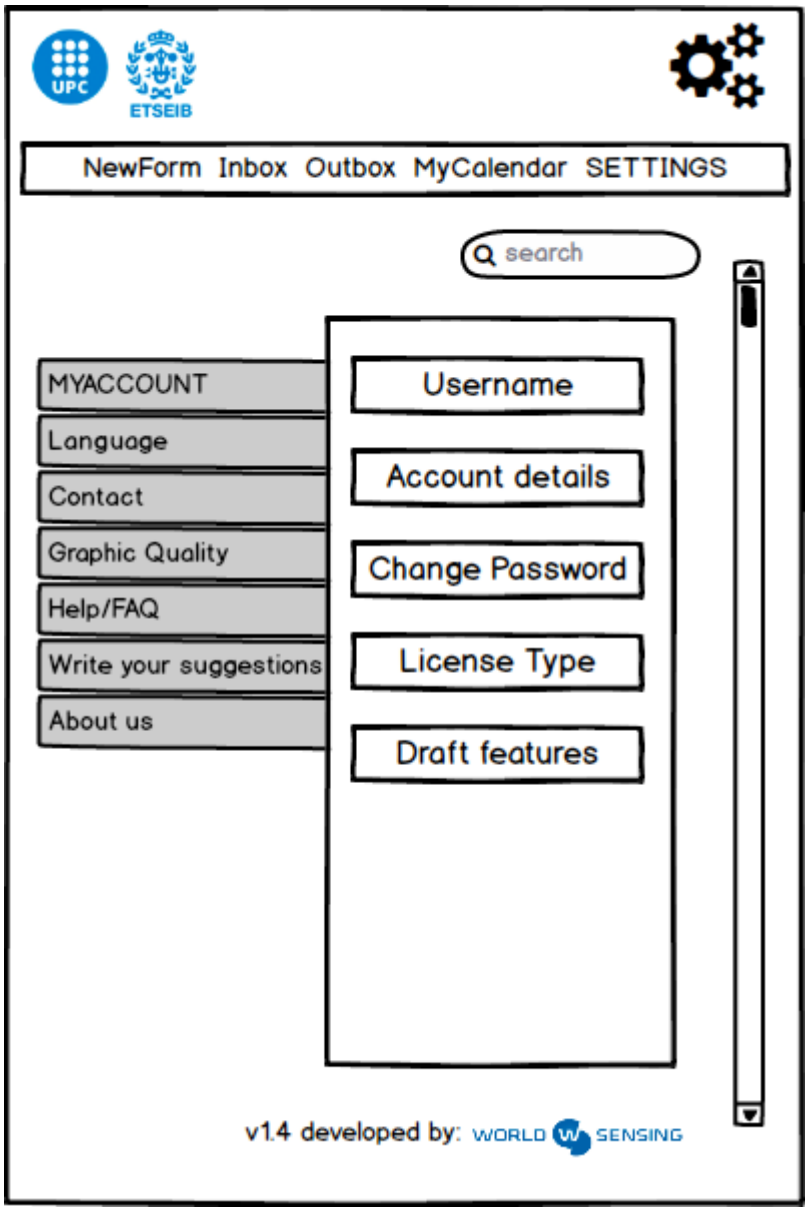

Figure C.8 Settings menu of the app

Annex D: Website list of features

The following Annex is dedicated to state all included features in the website service. As done with the app, this is a support to the content included in chapter 6.4: Data Management. Furthermore, it also includes features included in Dashboard, the solution related to chapter 6.5: Data Presentation. In Figure D.1 we have a sum-up of each website segment to describe. From Figure D.2 to Figure B.8 all features are shown following the website dock order.

Dashboard	Schedule	Reporting	Analytics	MyForms	LiveMap	Settings
LiveMap	Work orders	New report	New graphic	New form	Elements on map	Account details
Work orders	Dispatching	Correction of forms	List of graphics	List of forms	Elements info	Language
Performance	List of inspections	List of reports	Destination of graphics		Summary of inspections	User administration
MyForms		Destination of reports	Summary of graphics			Support
Manager Inbox		Summary of reports				Contact
Module Management		Reports search				Security
						Invoicing
						Feedback & suggestions

Figure D.1 High level list of website features

Dashboard	LiveMap	Asset location	
		Asset inspection	Date
			Inspector
			Site
			Quick dispatching
	Work orders	Calendar of monthly inspections	
	Performance	Analytics' graphs attaching	
	MyForms	List of current forms	
	Manager Inbox	Messages from Inspectors	
	Module management	Addition	Drag&Drop
		Visualization	Access to menu
		Deleting	
		Downloading	

Figure D.2 List of features to include in Dashboard menu of the website

Schedule	Work orders	Creation		
		Edition		
		Scheduling		
	Dispatching	Single	Parameters	Inspectors
				Forms
				Date
		Massive (data import)		Site
				Description of work order
				Other comments
	List of inspections	Filtering	Site	
			Inspector	
			Date	
			Owner	
			Performance	
			Asset health	
		Visualization / Downloading		
		Deleting		

Figure D.3 List of features to include in Schedule menu of the website

Reporting	New Report	Custom / from templates	Data import	Filtering
			Forms election	
			Reports destination	
			Reports format	PDF
				HTML
	Correction of forms	Substitution		
	Destination of reports	Mail account		
		Cloud storage service		
		Hard drive		
		Hybrid setting		
	List of reports	Filtering	Site	
			Inspector	
			Date	
			Owner	
			Performance	
			Asset health	
		Visualization / Downloading		
		Deleting		
	Summary of reports	Filtering		
		Order of reports	Chronological	Descending (newest first)
				Ascending (oldest first)
			By page	Ascending (page 1 first)
	Report search	Input	Alphanumeric	

Figure D.4 List of features to include in Reporting menu of the website

Analytics	New graphic	Custom / from templates	Data import	Filtering
			Reports election	
			Graphics destination	
			Graphics format	PDF
				HTML
	List of graphics	Filtering	Date	
			Variable	Custom
				From templates
		Visualization / Downloading		
		Deleting		
	Graphics destination	Mail account		
		Cloud storage service		
		Hard drive		
	Summary of graphics	Filtering		
		Order of graphics	Chronological	Descending (newest first)
				Ascending (oldest first)
			By page	Ascending (page 1 first)
		Amount of graphics shown		

Figure D.5 List of features to include in Analytics menu of the website

MyForms	New Form	Layout	Custom	
			From template	
		Fields	Input questions	Alphanumeric (keyboard)
				Multi-option
				Yes/No
			Support	Picture
				Audio
				Video
				Barcodes
				QR
				Online signature
				Calculator
			Phone extracted data	Date & time
				Geographical location
		Linked questions	One answer, one question	
			Multiple answer, one question	
		Branding	Customer logo	
	List of forms	Edition		
		Deleting		
		Downloading		
		Structure	Import data	ERP
				Format
			Export data	Physical Drive
				Cloud storage
				Mail direction
		Users rights	Managers	
			Inspectors	
		Format	HTML	
			PDF	
			Word	

Figure D.6 List of features to include in MyForms menu of the website

<table>
<tr><td rowspan="11">LiveMap</td><td rowspan="2">Elements on map</td><td>Site</td><td colspan="3"></td></tr>
<tr><td>Inspector</td><td colspan="3"></td></tr>
<tr><td rowspan="9">Element info</td><td rowspan="5">Site</td><td>Number of assets</td><td colspan="2"></td></tr>
<tr><td>Owner</td><td colspan="2"></td></tr>
<tr><td>Customer</td><td colspan="2"></td></tr>
<tr><td rowspan="3">Inspections</td><td>Made</td><td></td></tr>
<tr><td>Last</td><td rowspan="3">Inspector dispatched</td></tr>
<tr><td>Next</td></tr>
<tr><td>First</td><td></td></tr>
<tr><td rowspan="4">Inspector</td><td>Inspections made</td><td colspan="2"></td></tr>
<tr><td>Next inspection</td><td colspan="2"></td></tr>
<tr><td>First inspection</td><td colspan="2"></td></tr>
<tr><td>Performance</td><td colspan="2"></td></tr>
<tr><td rowspan="3">Summary of inspections</td><td rowspan="2">Visualization</td><td>Date</td><td colspan="2"></td></tr>
<tr><td>Inspector</td><td colspan="2"></td></tr>
<tr><td>Downloading</td><td colspan="3"></td></tr>
</table>

Figure D.7 List of features to include in LiveMap menu of the website

Settings	Language	English	
		Spanish	
		Catalan	
		French	
	Account details	Username	
		Password	
		Branding	
	Contact	Technical support	
		Consulting service	
		List of users	
	User administration	User rights	Manager
			Inspector
		User access	Addition
			Subtraction
		Creation	
		Deleting	
	Support	FAQ	Link to company website: FAQ
		Tutorials	Link to company website: tutorials
	Security	Data encryption	
		Credentials of users	
	Invoicing	Credit card	
		Debit card	
		PayPal	
	Feedback & suggestions		

Figure D.8 List of features to include in Settings menu of the website

Annex E: Website mock-ups

In the same way as Annex C, this section is dedicated to visually represent the website in this case.

All mock-ups were developed using Balsamiq software.

In blue we can check again the link between content from one menu to another one. And there are also several clouds that explain in a few words what is that feature about.

Figure E.1 to Figure E.13 is the list of mock-ups developed regarding the website service.

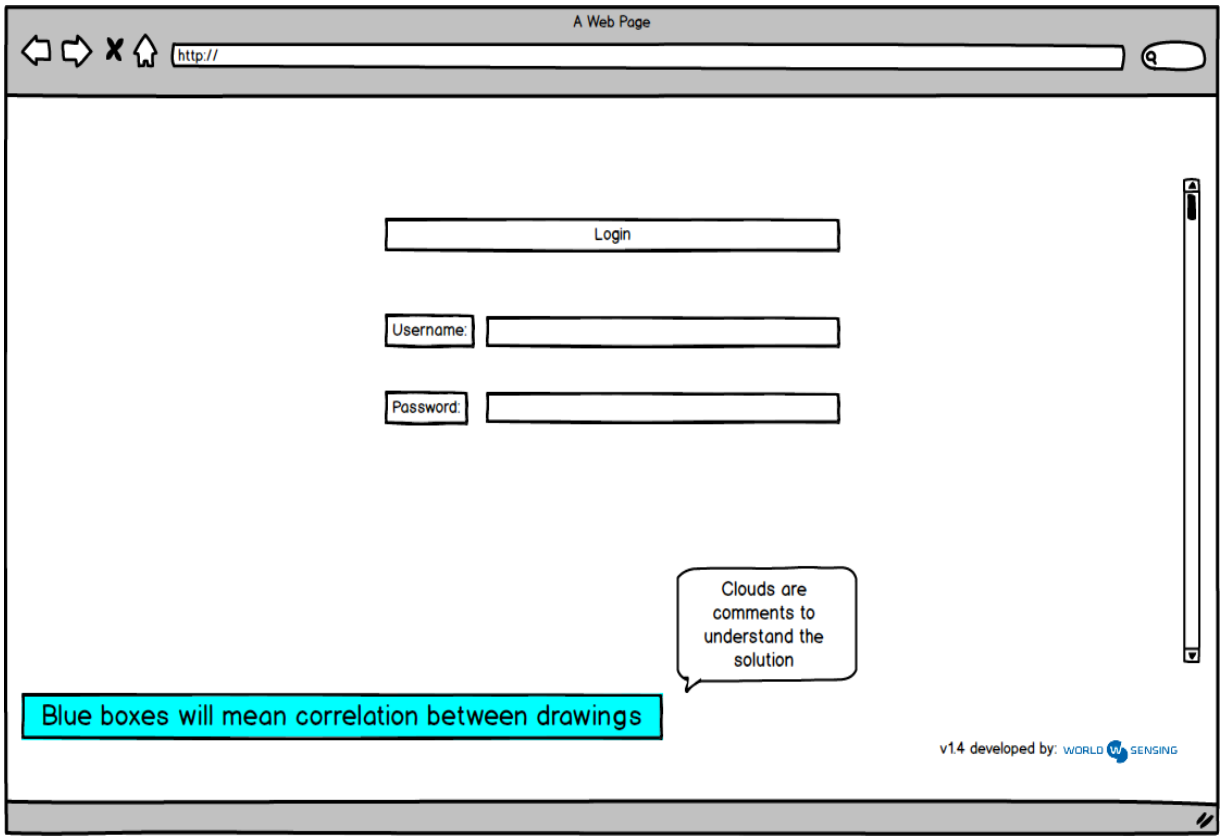

Figure E.1 Login menu of the website

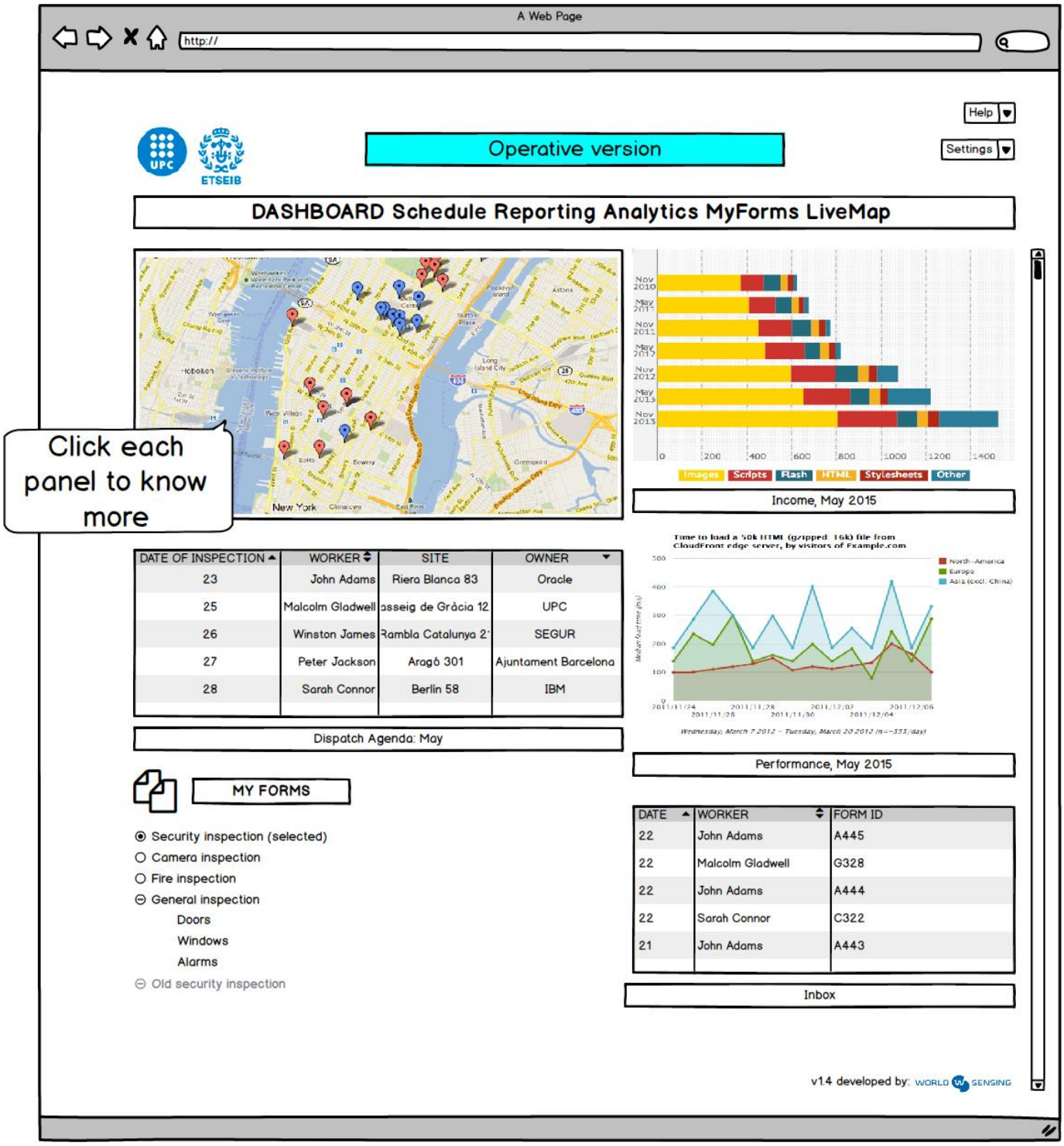

Figure E.2 Dashboard menu of the website

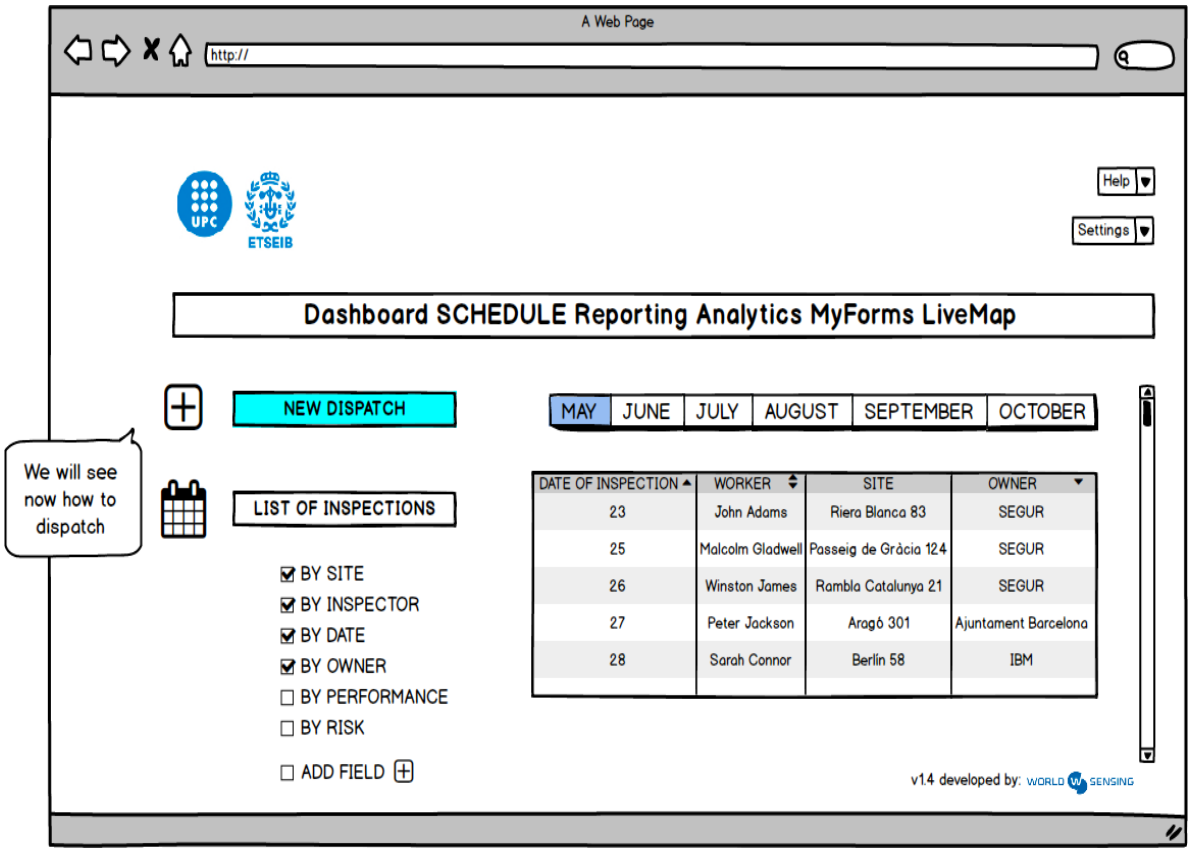

Figure E.3 Schedule menu of the website

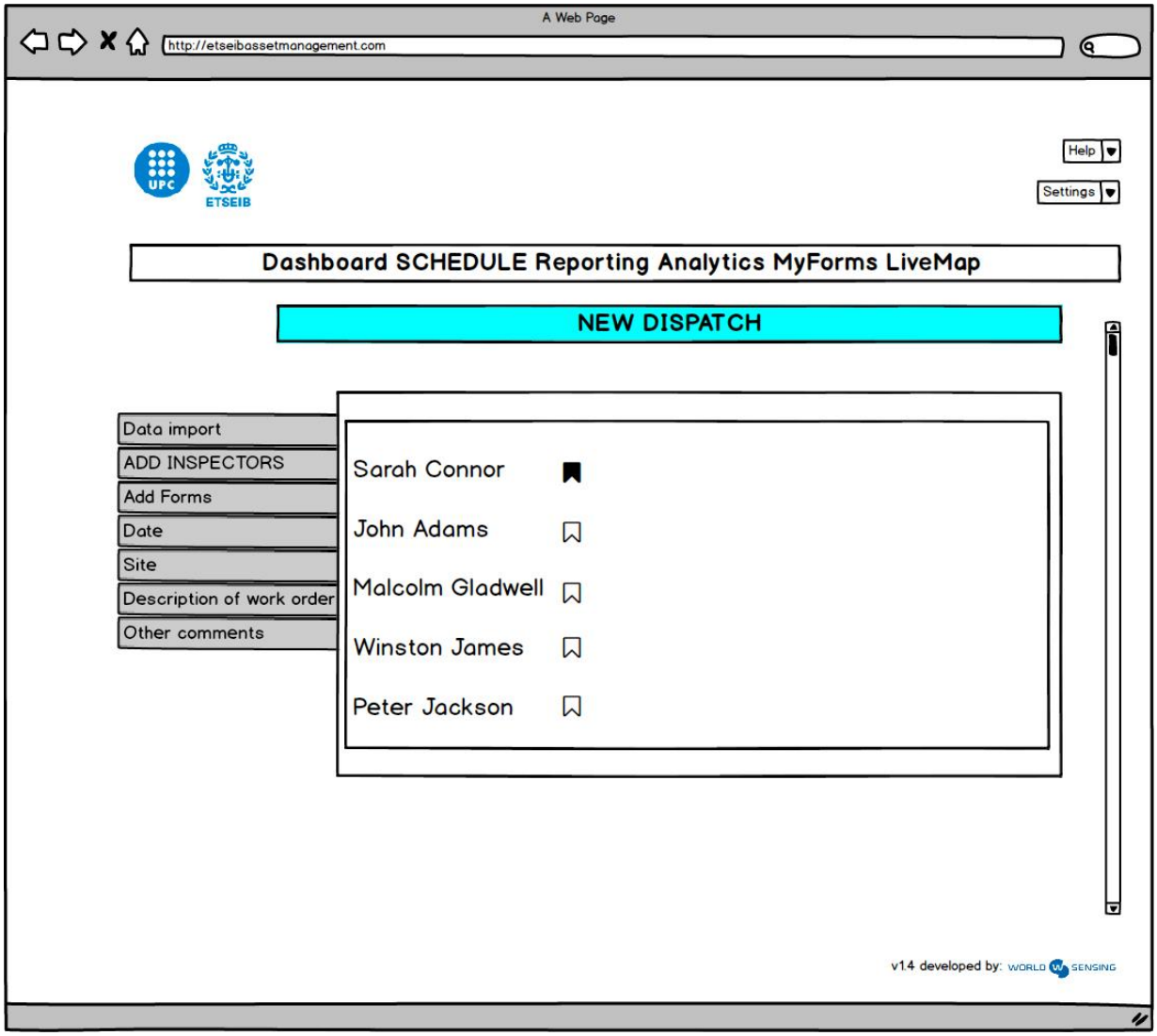

Figure E.4 Dispatching of a work order menu of the website

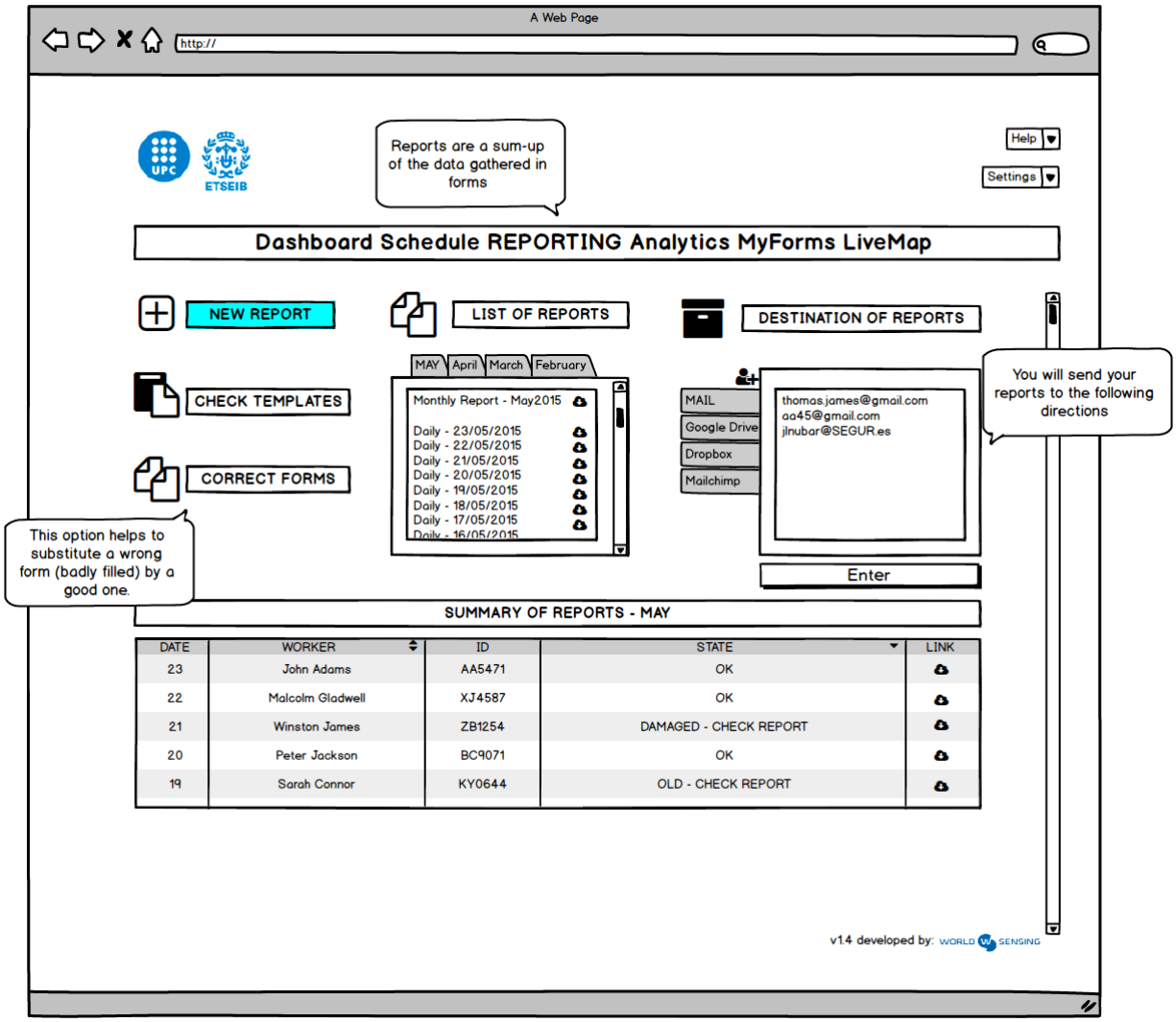

Figure E.5 Reporting menu of the website

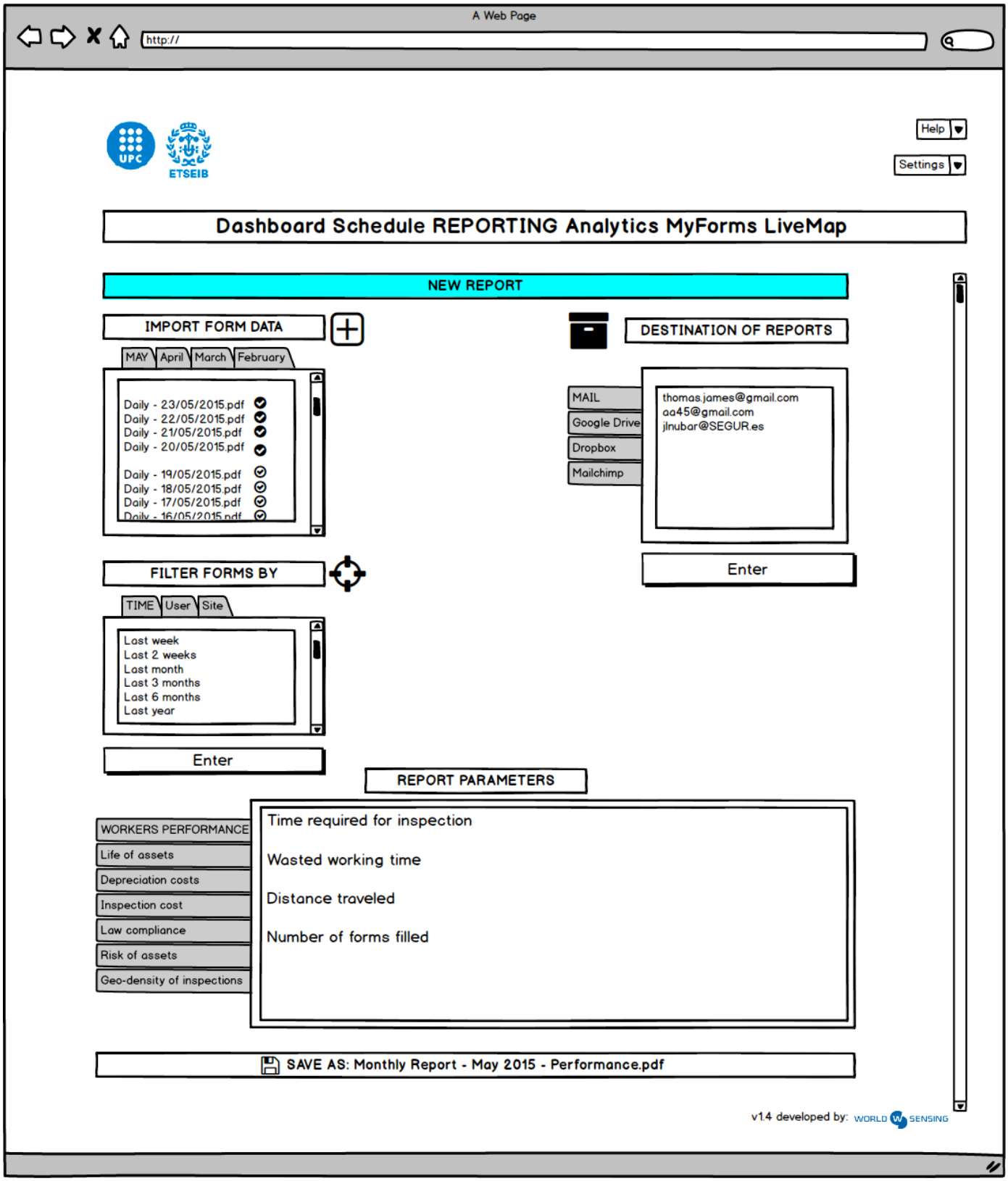

Figure E.6 Creation of a new report menu of the website

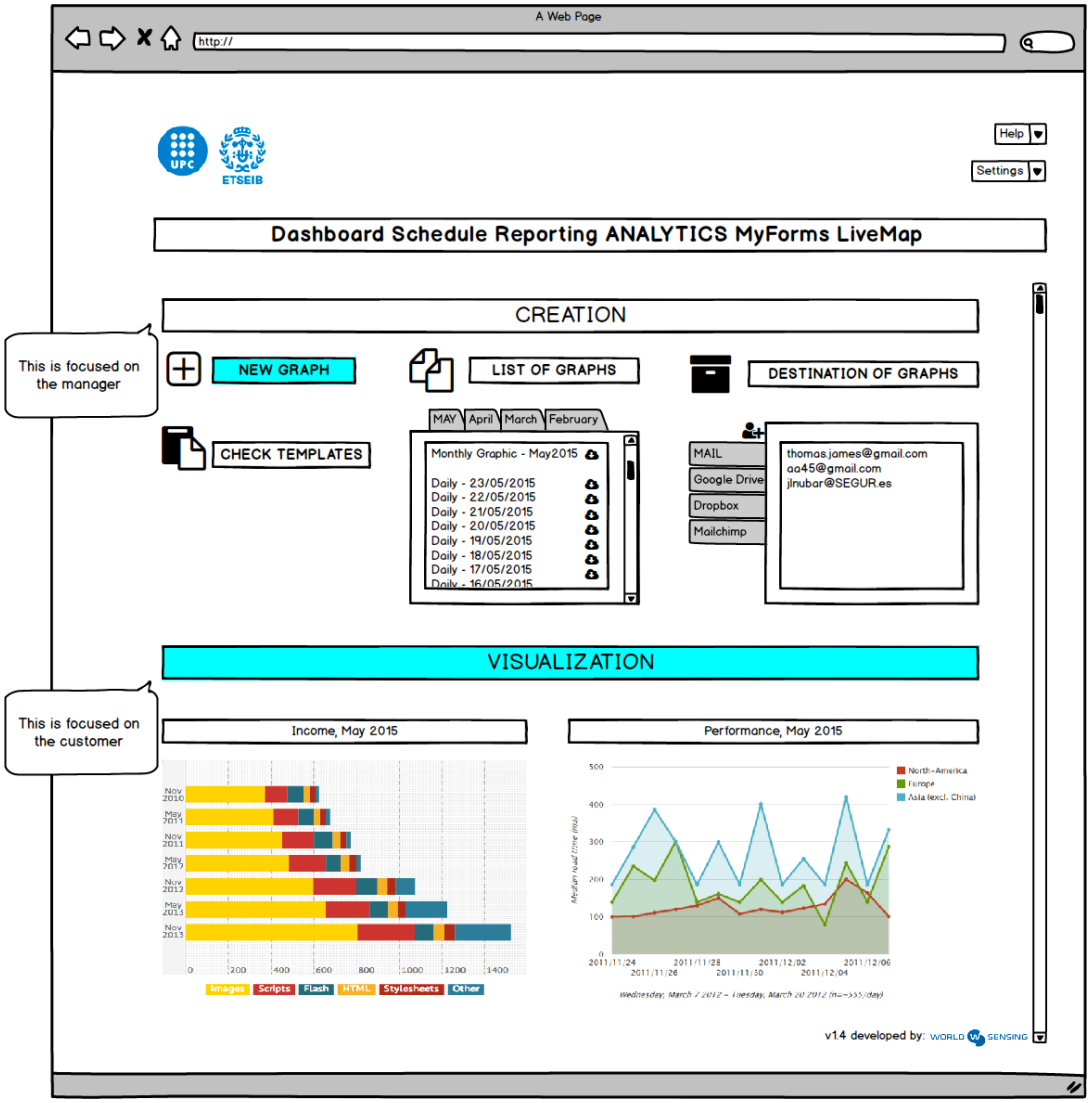

Figure E.7 Analytics menu of the website

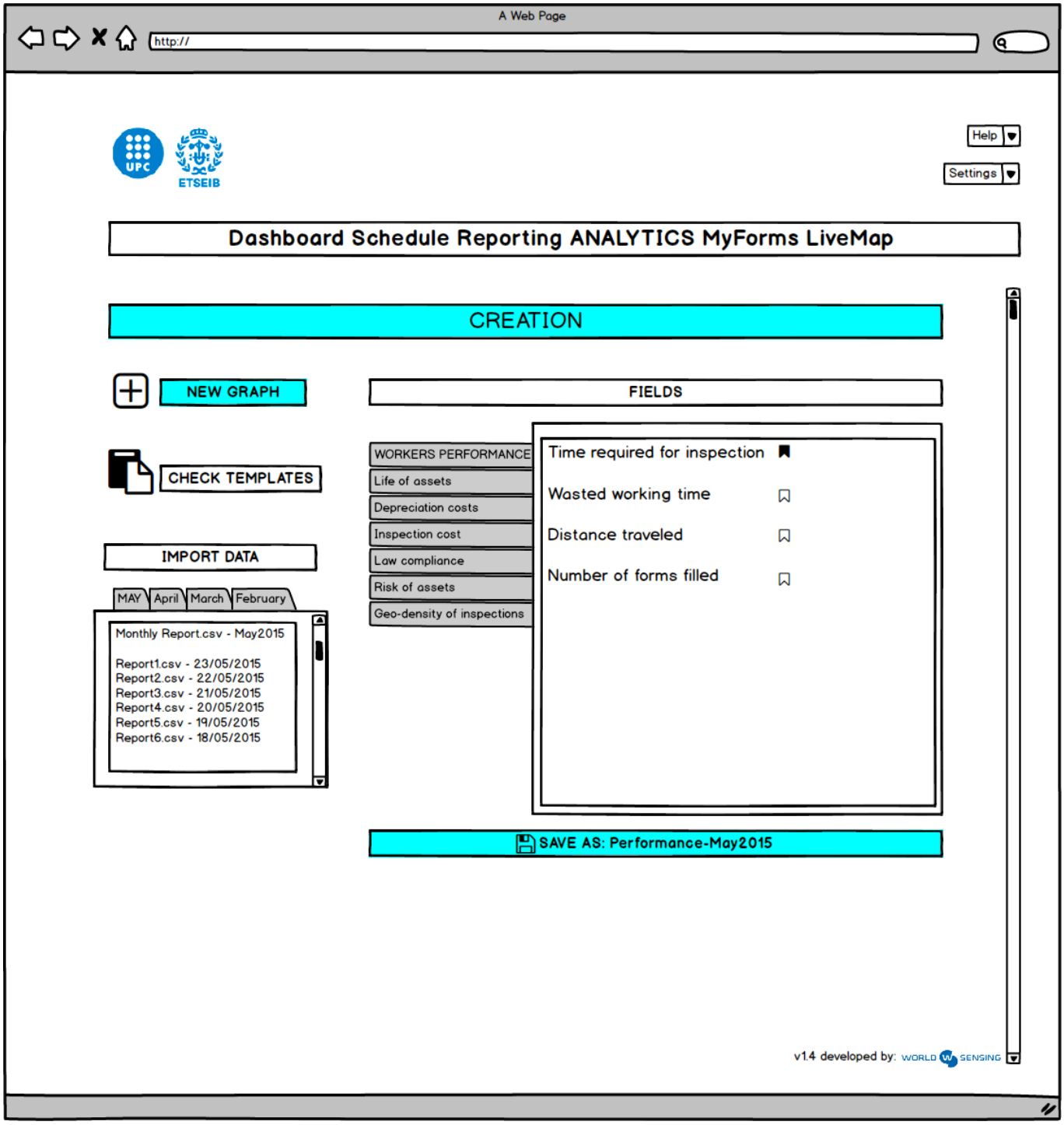

Figure E.8 Creation of a new graph menu of the website

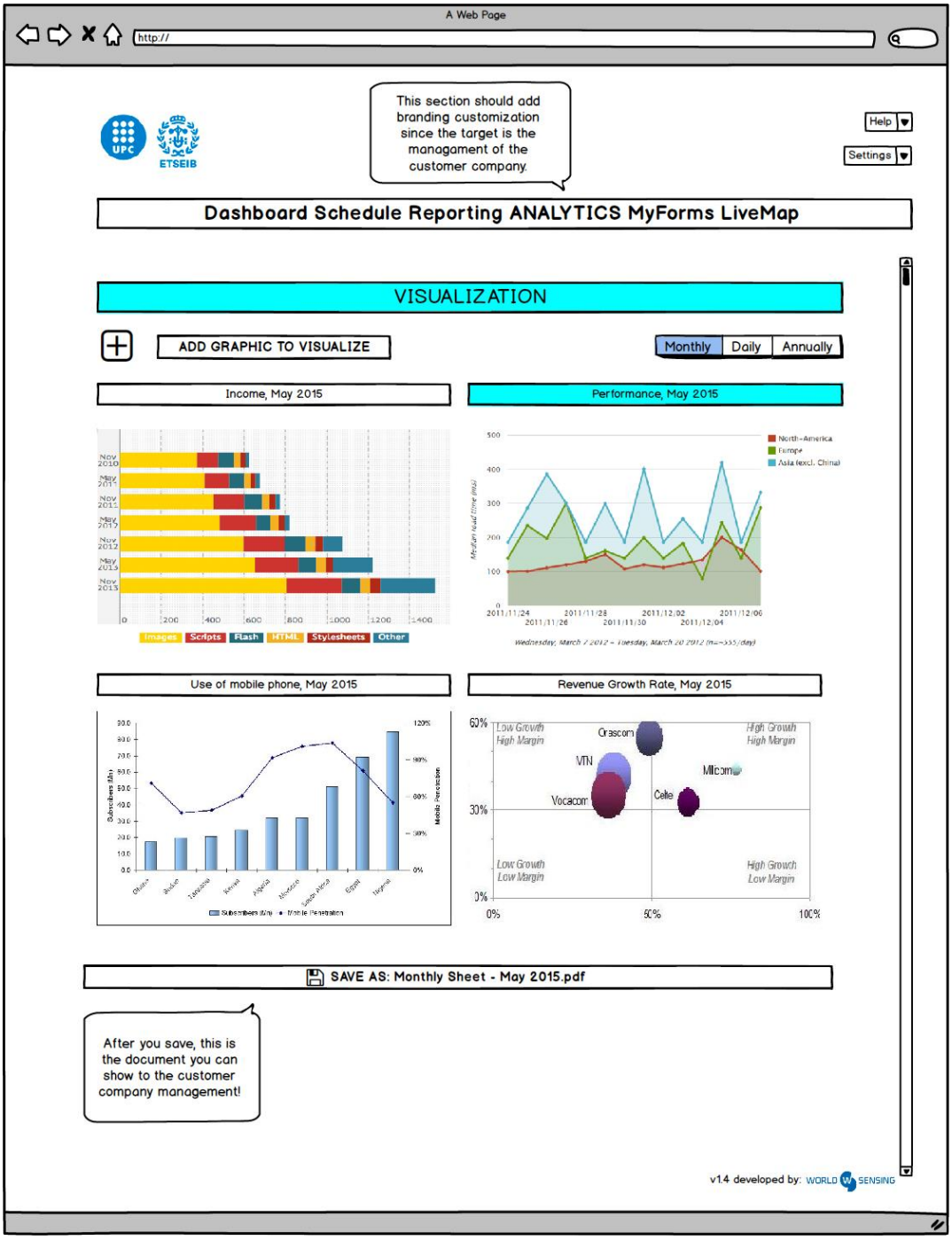

Figure E.9 Visualization of graphs menu of the website

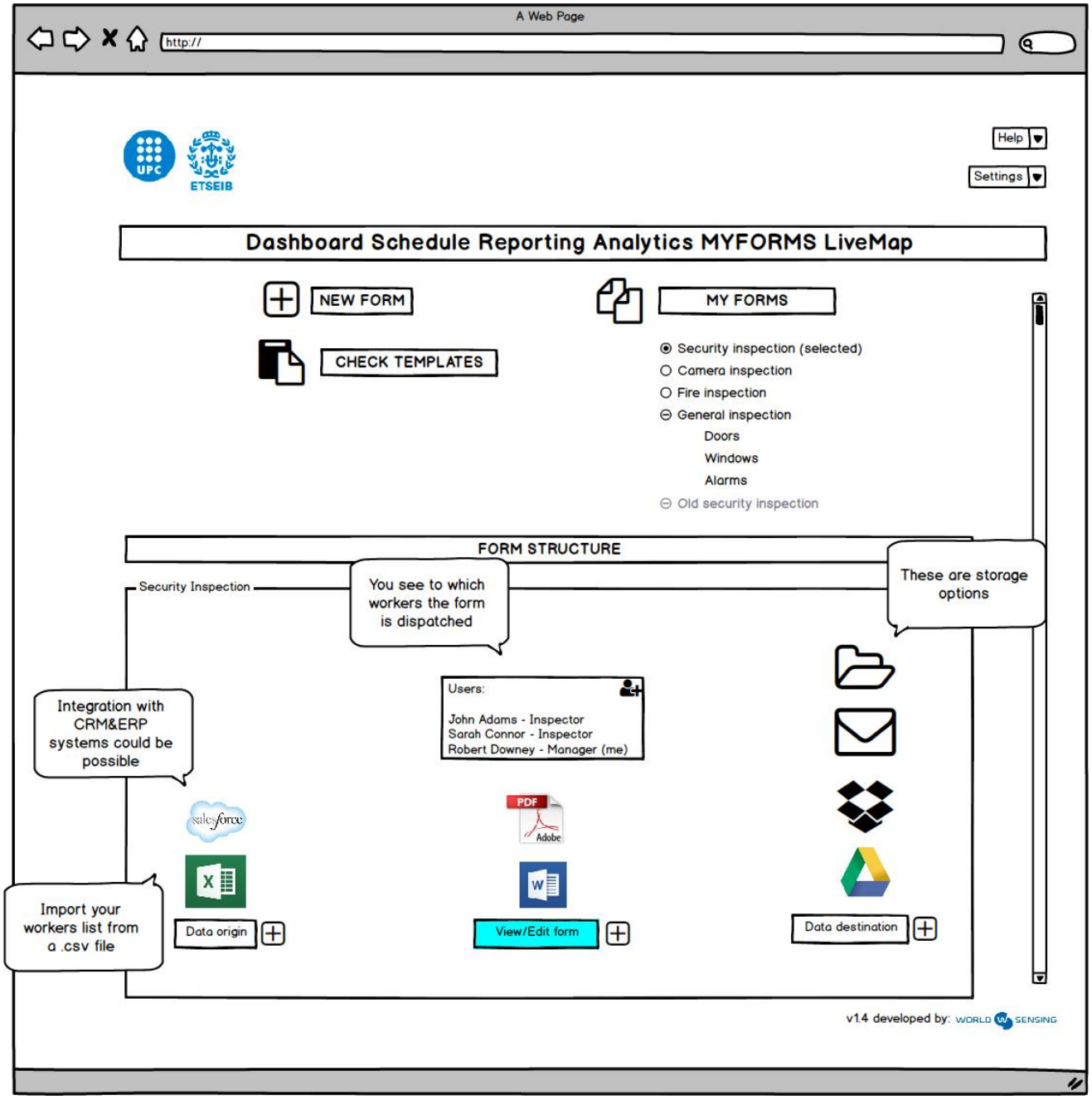

Figure E.10 MyForms menu of the website

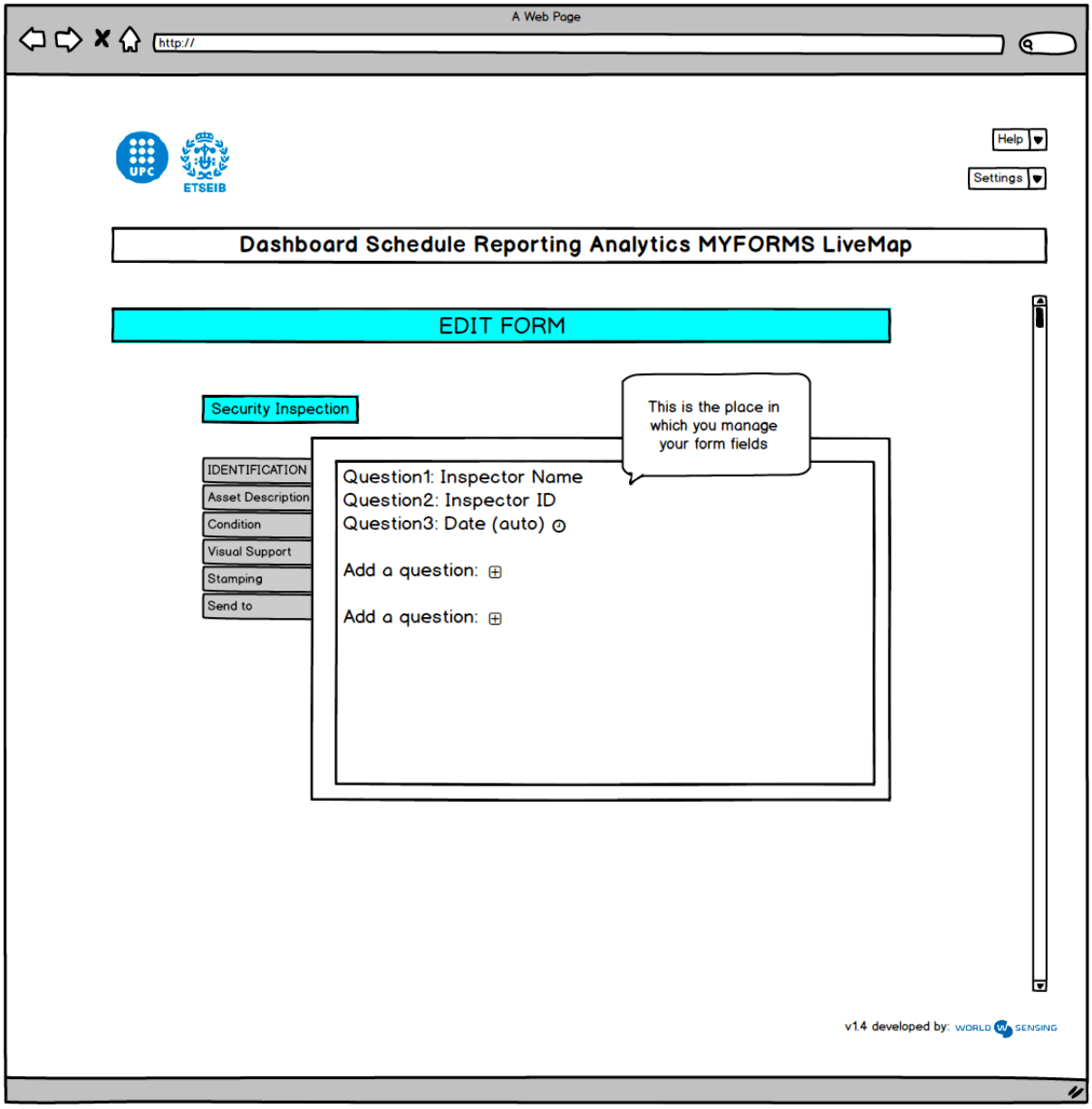

Figure E.11 Form editing menu of the website

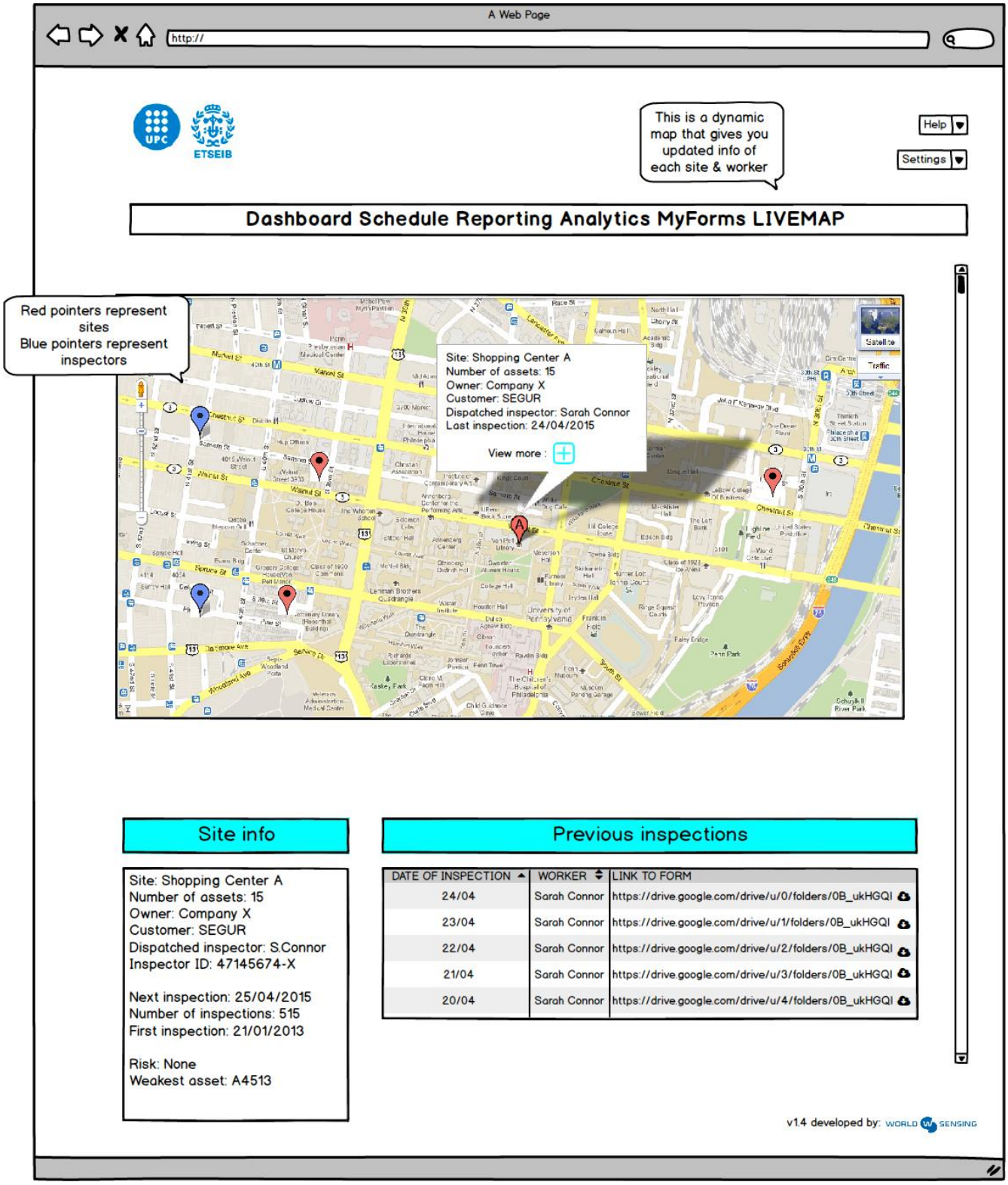

Figure E.12 LiveMap menu of the website

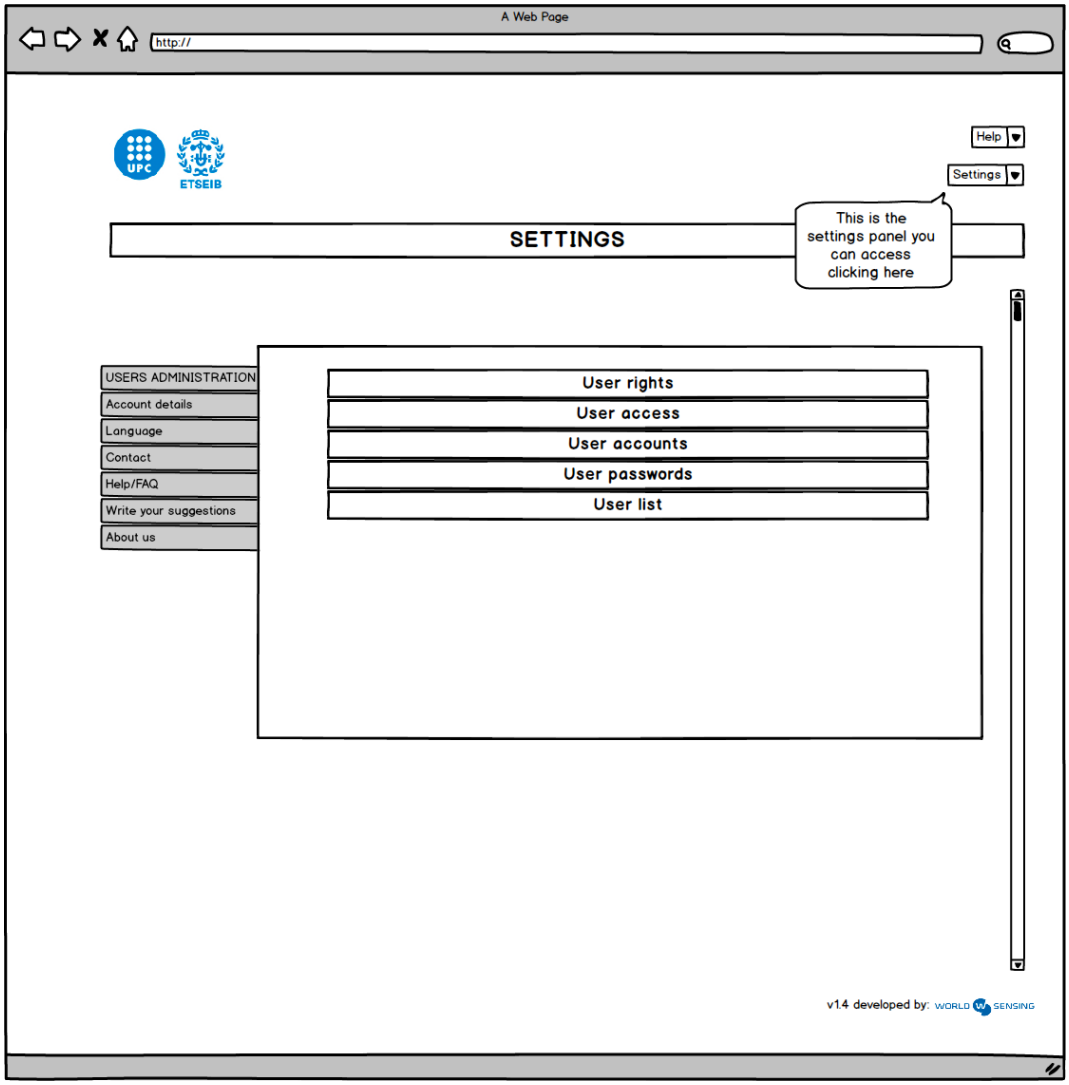

Figure E.13 Settings menu of the website

Annex F: Auxiliary information

This Annex is dedicated to include some extra data regarding the project.

Figure F.1 is an example to specify a fact that was not explained enough during the memorandum. There is the situation where an inspector may fill a form in an incorrect way. If inspectors realize this mistake during the form filling process, they can always cancel that form. But there is the possibility that they realize after sending it. Or even they don't realize about the mistake, but the manager does. For this reason, there is the replacement process:

1. Inspector fills a form
2. For some reason, form is not correct
3. Inspector then fills another form to the same asset (same work order)
4. Inspector sends the new form to the manager with a comment "Form A to replace Form B".
5. Manager goes to the sub-menu "Replace Form" in the "Reporting" menu of the website
6. Manager links both forms, stating which is replacing which.
7. Replacement of forms is done.

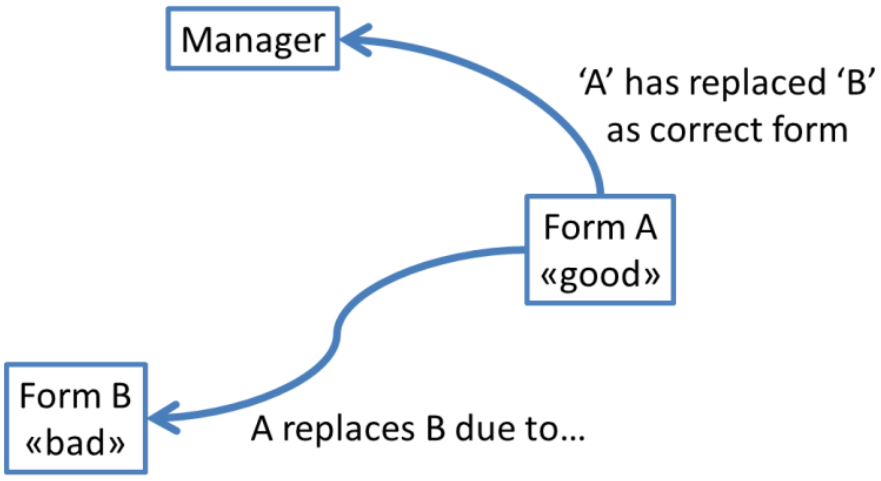

Figure F.1 Form replacement process

Last but not least, Figure F.2 is a sum-up of the inspection process approach. An inspection requires involvement from two bodies, inspector and user. Manager dispatches a work order to an inspector, who collects data of assets and sends it to managers.

Managers take care of data administration, plus the creation of reports for the final customer. Hence, this is the ad-hoc cycle, of collecting, transmitting, managing and presenting of data related to the status of assets.

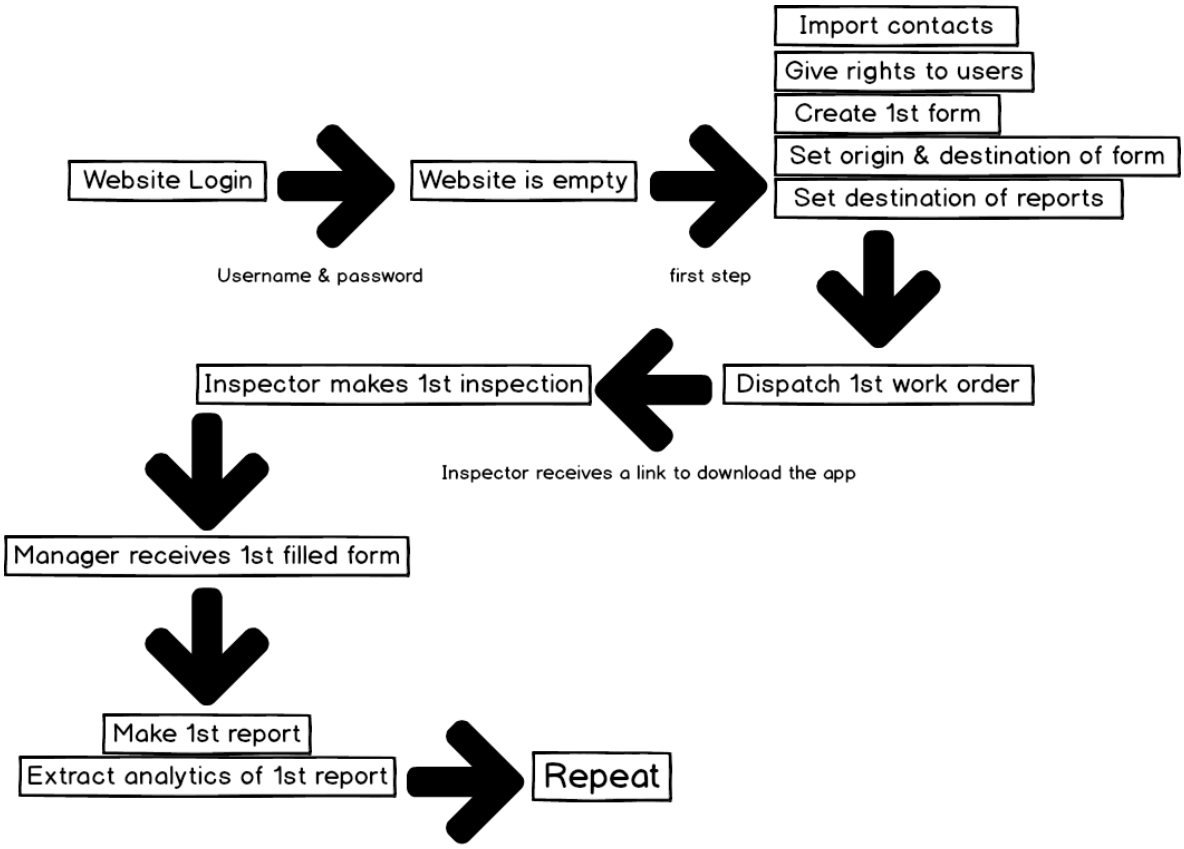

Figure F.2 EAM solution case of use